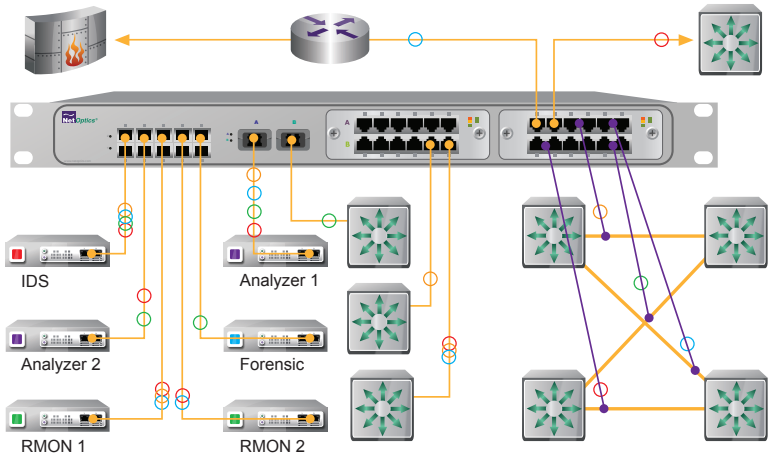
NetOptics®

User Guide

DIRECTOR™

"Smart Filtering" Appliance



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Additional Information

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Chapter 1
Introduction

Net Optics Director is a key component for building a comprehensive, consolidated monitoring infrastructure for both network management and security. It extends the range of visibility for data monitoring across converged data and digital voice networks, while eliminating monitoring port contention and minimizing the number of tools needed to optimally manage the network.

A single Director device enables you to tap into multiple network links, and direct their traffic to multiple monitoring ports. It includes aggregation and regeneration functions, so the link-to-monitor-port mapping can be one-to-one, one-to-many, many-to-one, or many-to-many. In addition, it provides filtering: Each Monitor port can be programmed to receive only traffic meeting user-defined filter criteria based on protocol, source and destination addresses, and network utilization. This filtering capability enables specific types of traffic such as voice over IP (VoIP) to be directed to particular monitoring tools.

Matrix switching, aggregation, and regeneration

Each Director chassis supports up to 12 in-line network links or 26 Span ports. For monitoring, up to 12 ports are provided. Network and Span ports can be aggregated and regenerated to output ports in almost any combination.

Modular design

Director is modular to provide configuration flexibility.

- Director Network Modules (DNMs) support SX (multi-mode) and LX (single-mode) fiber links and 10/100/1000 Copper links.
- Each DNM provides either 6 in-line network links or 12 Span ports.
- The Director Chassis includes two DNM slots; they can be populated with the same or different DNM types.
- Ten 1-Gigabit Monitor ports are SFP-based, accepting any mix of Copper, SX, and LX interface modules.
- Four 10-Gigabit ports are XFP-based, accepting SR, LR, and ER interface modules.

Flexible 10 Gigabit support

Two 10 Gigabit ports on the front of the unit can be configured as Network, Span, or Monitor ports. They can be configured for the same or different functions. Traffic from multiple 1-Gigabit Network or Span ports can be aggregated to a 10-Gigabit Monitor port. Conversely, traffic from a 10 Gigabit Network or Span port can be dis-aggregated to multiple 1 Gigabit Monitor ports through appropriate filtering. For example, traffic from different IP address ranges could be directed to separate Monitor ports.

Expandable

An additional two 10 Gigabit ports on the rear of the unit enable daisy-chaining up to ten Director chassis to expand the number of available ports, for a total of 380 ports in a fully expanded system (when available).

Monitor port-based filtering

Director avoids the confusion of pre-filtering versus post-filtering by strictly tying filtering to the Monitor ports. Each Monitor port can be configured to have traffic from any number of Network or Span ports directed to it, and each Monitor port applies up to 30 protocol-, address-, and utilization-based filters to the traffic.

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Key Features

Ease of Use

- Tap, aggregation, regeneration, matrix switch, and filter functions in a single device
- 19-inch rack frame, 1U high
- Front-mounted connectors for quick and easy installation
- LED indicators show Power, Link, and Activity status
- Modular design for configuration flexibility
- RMON statistics, including network utilization thresholds and filtering; data can be used to assemble XML-based end-user reports, or it may be exported to a third party reporting tool such as a protocol analyzer
- Text-based command-line interface (CLI) available through RS-232 serial port
- CLI also available remotely over secure SSH connection
- Field-upgradeable software
- Compatible with all major manufacturers' monitoring devices, including protocol analyzers, probes, and intrusion detection and prevention systems

Monitor port Filtering

- 1,000 filter elements per a chassis
- Exclusive (drop matched packets) and inclusive (pass matched packets) filters
- Filters based on IP protocol, IP addresses, layer 4 ports, MAC addresses, and VLANs
- Source and destination MAC addresses
- Source and destination IP addresses, or ranges of addresses
- Source and destination ports
- VLAN
- Network port utilization
- Protocols: all IP protocols such as ICMP, TCP, UDP, and RDP

Passive, Secure Technology

- Passive access at up to 10 Gbps
- In-line links do not interfere with the data stream or introduce a point of failure
- Optimized and tested for 10, 100, and 1000Mbps copper and 1 and 10 Gpbs fiber networks
- Redundant power to maximize uptime
- In-line links default to open under a complete power-fail condition, ensuring network availability
- FCC, CE, VCCI, C-Tick, and WEEE certified
- Fully RoHS compliant

Unsurpassed Support

- Net Optics offers technical support throughout the lifetime of your purchase. Our technical support team is available from 8:00 to 17:00 Pacific Time, Monday through Friday at +1 (408) 737-7777 and via e-mail at ts-support@netoptics.com. FAQs are also available on Net Optics Web site at www.netoptics.com.

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About this Guide

Please read this entire guide before installing Director. This guide applies to the following part numbers:

Chassis Part Number	Description
DIR-3400	Director Main Chassis with 10 SFP monitor ports
DIR-____	Director Main Chassis with 10 SFP monitor ports, -48VDC power
DIR-7400	Director Main Chassis with 10 SFP monitor ports, 2 XFP 10GbE ports, 2 XFP uplink ports
DIR-____	Director Main Chassis with 10 SFP monitor ports, 2 XFP 10GbE ports, 2 XFP uplink ports, -48VDC power
DNM Part Number	**Description**
DNM-100	6-Port 10/100/1000 Copper In-Line Module
DNM-110	12-Port 10/100/1000 Copper Span Module
DNM-200	6-Port Gigabit SX Fiber 62.5µm In-Line Module
DNM-210	12-Port Gigabit SX Fiber 62.5µm Span Module
DNM-220	6-Port Gigabit SX Fiber 50µm In-Line Module
DNM-230	12-Port Gigabit SX Fiber 50µm Span Module
DNM-300	6-Port Gigabit LX Fiber In-Line Module
DNM-310	12-Port Gigabit LX Fiber Span Module
DNM-320	6-Port Gigabit ZX Fiber In-Line Module
DNM-330	12-Port Gigabit ZX Fiber Span Module

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Director Architecture

The following diagram shows a schematic view of the architecture of the Director device shown as a Matrix Switch with filtering. The black dots indicate aggregating Matrix Switch connections between Network Ports and Monitor Ports.

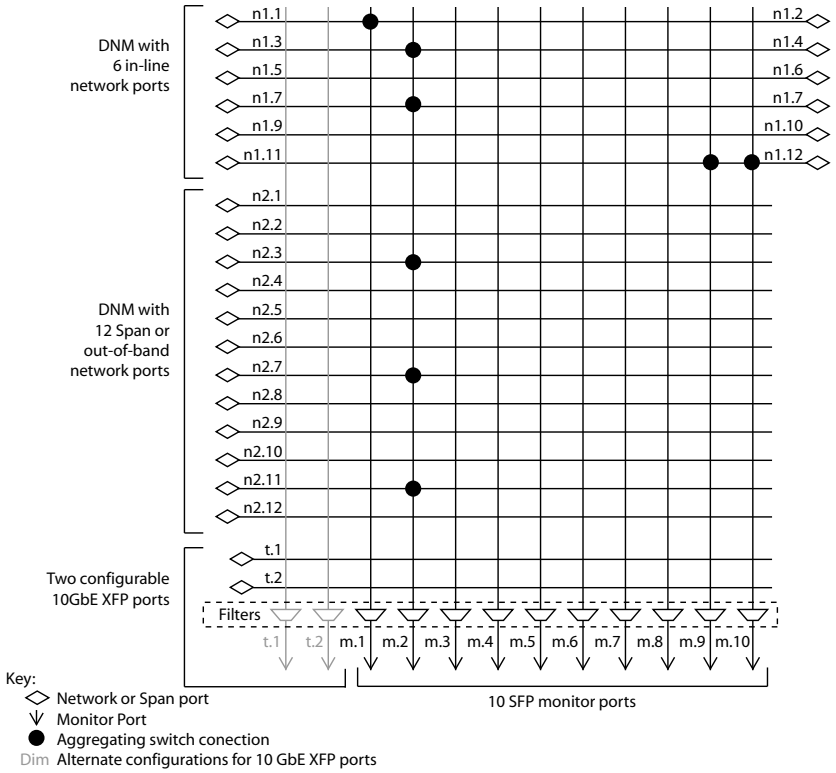

Figure 1: Director internal architecture

Director can be viewed as a matrix switch with up to 26 inputs, or Network ports, and 12 outputs, or Monitor ports. Any number of inputs can be directed to each of the outputs; Director aggregates the traffic from those Network ports and sends them to the Monitor ports. For example, the diagram shows:

- Traffic from the first in-line Network link (n1.1-n1.2) is being directed to the first SFP Monitor port (m.1)
- Traffic from two in-line Network links (n1.3-n1.4 and n1.7-n1.8) plus three Span Network ports (n2.3, n2.7, and n2.11) is being aggregated and directed to the second SFP Monitor port (m.2)
- Traffic from one in-line Network link (n1.11-n1.12) is being regenerated to two SFP Monitor ports (m.9 and m.10)

The traffic from the in-line Network links to the Monitor ports may include the traffic being received at the odd-numbered Network port (at the left side of the diagram), at the even-numbered Network port (at the right side of the diagram), or both; the diagram doesn't include this level of detail.

In addition, filters (shown at the bottom of the diagram) are configured independently for each Monitor port, one or more filters per port, and applied on the aggregated traffic for that port. For example, the second SFP Monitor port could have two filters, where one filter selects the TCP traffic from the two in-line Network links and the second filter selects the UDP traffic from the three Span Network ports.

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The inputs are divided into three groups: two DNMs plus the 10GbE ports. In-line DNM models support 6 in-line links, while Span DNM models support 12 Span ports. The diagram shows one in-line and one Span DNM. Both in-line and Span DNMs are available with either Copper or SX Fiber interfaces. Different DNM types can be mixed in the same chassis, for example, one in-line Copper DNM and one Span Fiber DNM. The modules are hot-pluggable for easy serviceability. One or both DNM slots can be populated. The DNM slots are numbered 1 for the slot on the left and 2 for the slot on the right. If only one slot is populated, it should be slot 1.

The two configurable 10-Gigabit XFP ports are shown in the first two columns and last two rows of the diagram. The two dark black rows indicate that both ports are configured as Span inputs. The two dimmed columns indicate that the ports can alternately be configured as Monitor ports. The two ports may be configured as:

- Both Span
- Both Monitor
- One Span and one Monitor

USB port

A USB port located on the back is reserved for future functionality.

Director Management

Director can be configured and managed using a command-line interface (CLI) that will be familiar to most network administrators. The CLI runs locally over an RS-232 serial port or remotely over a secure SSH connection.

Net Optics GUI-based Compass management tools, which will be available soon, include:

- **Web Manager**—A Web-browser based tool to manage a single Director (at a time) from anywhere in the world
- **System Manager**—An SNMP platform-based tool to mange all the Director and other Net Optics iTap-enabled devices on your network

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Typical Application

The following diagram shows a typical application using Director to implement a comprehensive, consolidated monitoring infrastructure.

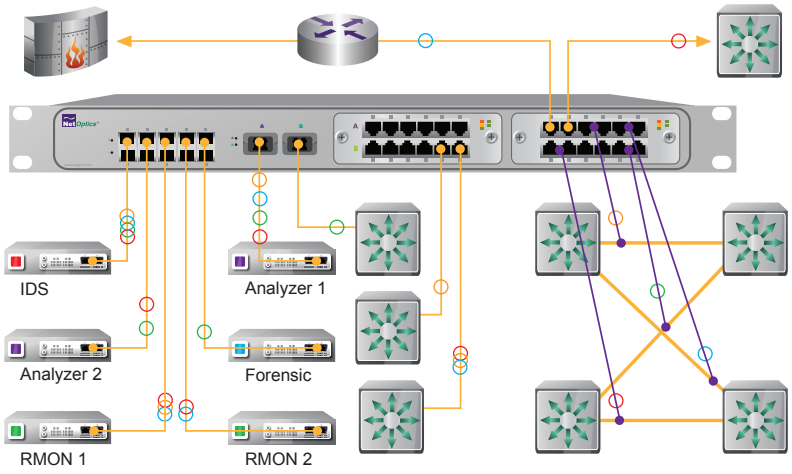

Figure 2: Director-centric network monitoring infrastructure

In this example, eight network links are monitored by six monitoring devices. The company's external access is protected by a firewall, shown in the upper left of the diagram. The link runs through a router, then in-line through Director, and then to a switch that distributes traffic throughout a department.

Network Links

The rest of the department's switches are shown, but only the connections to Director are illustrated. The four department switches shown in the lower right are cross-connected for fault tolerance. All four of the cross-connected links are passed in-line through Director (as indicated by the slanting purple lines) so they can be thoroughly monitored for performance tuning, security, and trouble-shooting. Because so many critical links pass in-line through Director, it's good to know that they are completely passive connections—Director does not slow down or interfere with the in-line traffic, and the links stay open to pass traffic even if both of the Director power supplies are removed. (When power is removed, 10/100/1000 Copper in-line links may be dropped for a short period of time—less than 1 second—while relays switch to open the link. Subsequently, the network re-establishes the links and traffic resumes flowing.)

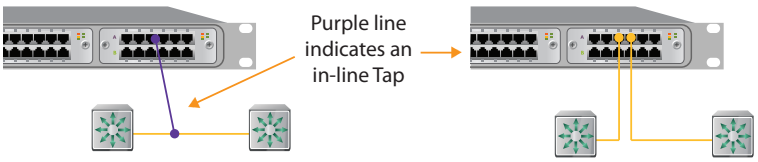

Figure 3: Detail of in-line Taps shown in Figure 2

In the middle of Figure 2, three other departmental switches are monitored through their Span ports. One of the switches handles 10GbE traffic, so its Span port goes to one of the Director 10GbE XFP ports. One of the other switches' 1GbE Span ports carries three distinct types of traffic–e-mail, VoIP, and Web pages–as indicated by the three colored circles on the Span link.

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In this installation, Director has ten additional Span ports and one in-line link that are available for expansion, when more links need to be monitored.

Monitoring Tools

Still referring to Figure 2, six monitoring tools are connected to Director. They include protocol and performance analyzers, RMON probes, and an intrusion detection system (IDS). Any of the monitoring tools can be used to observe any of the connected network links, and the connections can be switched easily, using the Director CLI, without ever moving a cable or touching the tools. A set of possible data flows is indicated by the colored circles on the links in the diagram.

One of the network monitoring tools is capable of handling more than 1 Gbps, so it is attached to a 10 Gigabit XFP port. Through this port, the tool can be sent aggregated traffic up to 10 Gbps. For example, the colored circles in the diagram indicate that traffic from four links is being aggregated and sent to this port.

Four streams of traffic are also being aggregated to the red monitoring tool on the upper left. Since this is a 1 Gbps Monitor port, aggregated data up to 1 Gbps can be sent to the red tool. If the aggregated traffic exceeds 1 Gbps, packets will be dropped. To avoid dropping packets, filters should be configured to reduce the aggregated traffic load to 1 Gbps or less.

The two green RMON monitoring tools at the bottom are the same type of tool. Two identical tools provide the capability of monitoring a greater amount of data than a single tool can handle. Another reason to use identical monitoring tools is to provide redundancy in case one of the tools fails. In addition, Director can be configured to send different types of traffic to each tool, for example, all the TCP traffic to one tool, and the UDP traffic to the other.

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In-line Monitoring of 10 Gigabit Links

To create an in-line link on a 10 Gigabit network segment, use and external iBypass Switch or network Tap. These two methods are explained in the following sections.

iBypass Switch Method

One method for creating a fail-safe, passive in-line 10 Gigabit network connection with Director is to use an external iBypass Switch, as shown in the following diagram.

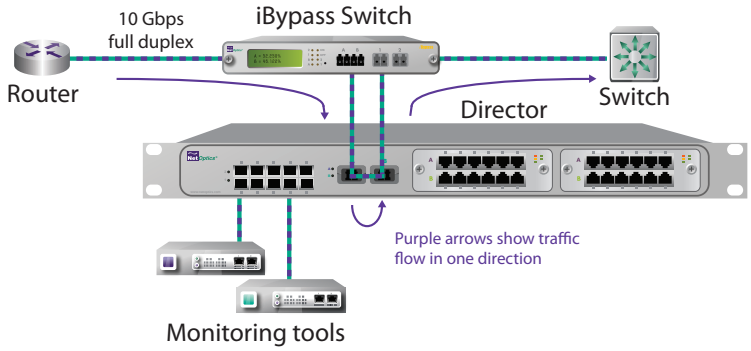

Figure 4: iBypass Switch method for 10 Gigabit in-line network connection

In this case, traffic flows from the router, into the iBypass Switch, down to the Director, through Director, back up to the iBypass Switch, and finally to the switch. It also travels in the opposite direction. If power is removed from Director or from the iBypass Switch, the iBypass Switch fails open, creating a passive connection that keeps traffic flowing between the router and the switch.

External Network Tap method

Another method for creating a fail-safe, passive in-line 10 Gigabit network connection with Director is to use an external network Tap, as shown in the following diagram.

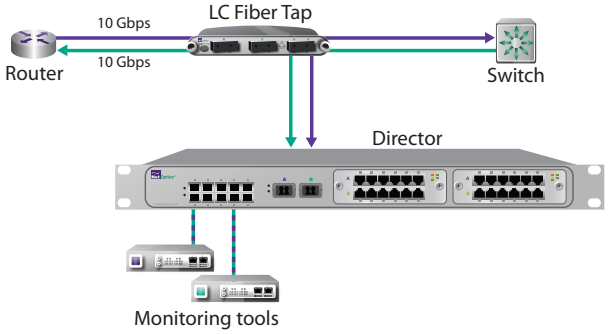

Figure 5: External Tap method for 10 Gigabit in-line network connection

In this case, traffic flows from the router, through the external Tap, to the switch. The Tap is totally passive, with no power needed for its operation. Optical splitters send a portion of the link light to the Director for monitoring. The Tap produces two half-duplex data streams, so both of Director's 10 Gigabit ports are used to monitor full-duplex traffic. A 10 GigaBit Port Aggregator can be used instead of a Tap to send the full-duplex link traffic to a single Director 10 Gigabit port, assuming the aggregated full-duplex traffic is 10 Gbps or less.

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Director Front Panel

The features of the Director front panel are shown in the following diagram.

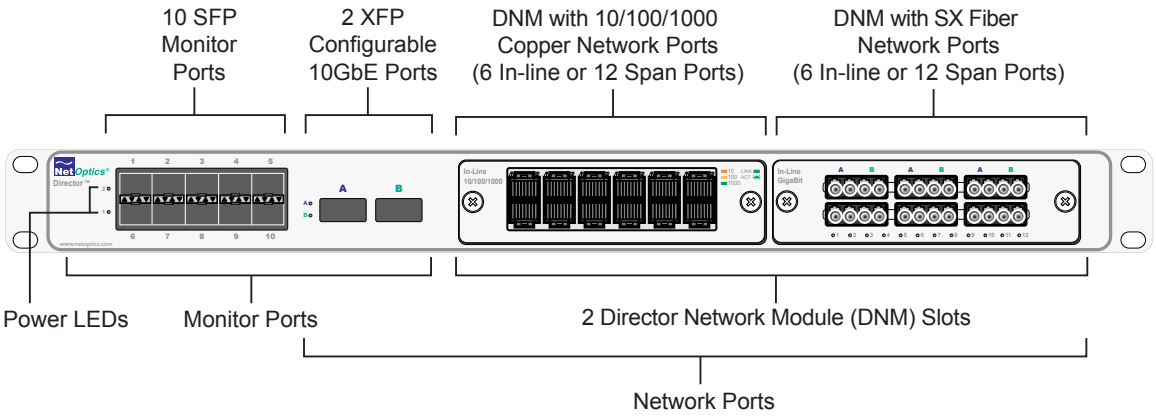
10 SFP Monitor Ports
2 XFP Configurable 10GbE Ports
DNM with 10/100/1000 Copper Network Ports (6 In-line or 12 Span Ports)
DNM with SX Fiber Network Ports (6 In-line or 12 Span Ports)
Power LEDs
Monitor Ports
2 Director Network Module (DNM) Slots
Network Ports

Figure 6: Director Front Panel

Monitor Port LEDs

Each Monitor port has two light-emitting diode (LED) indicators. The Link LED is illuminated when a link is established. The Activity LED blinks when traffic is passing through the port. They are located in the middle between the two rows of SFPs.

DNM / Network Port LEDs

Each 10/100/1000 Network or Span port has two LEDs. The Link LED is illuminated when a link is established. The Activity LED blinks when traffic is passing through the port. The Link LED also indicates the link speed: amber for 10Mbps, yellow for 100Mbps, and green for a 1000Mbps (1 Gbps). They are integrated in the RJ-45 connectors, Link on the left and Activity on the right.

Each 1-Gigabit Fiber Network or Span port has a single LED. It illuminates solid when a link is established, and it flashes when traffic is passing through the port. These Link LEDs are located below the LC fiber connectors.

10 Gigabit Port LEDs

Each configurable 10-Gigabit port has a single LED. It illuminates solid when a link is established, and it flashes when traffic is passing through the port. These Link LEDs are located to the left of the XFP fiber connectors.

Power LEDs

Two LED indicators for power, one for each of the redundant power supplies.

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Director Rear Panel

The features of the Director rear panel are shown in the following diagram.

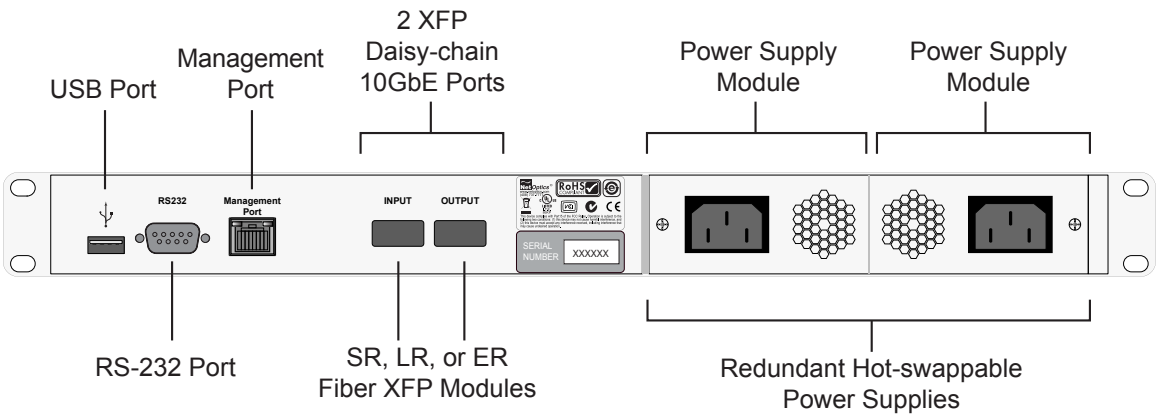

Figure 7: Director Rear Panel

Major features of the rear panel include:

- **USB Port**—Reserved for future functionality
- **RS-232 Port**—DB9 serial port for the CLI
- **Management Port**—A 10/100/1000 network port for the remote management interfaces and software updates; the CLI runs over an SSH connection through this port; Compass management tools, when available, will connect through this port
- **XFP Daisy-chain 10GbE Ports**—Accepts SR, LR, and ER XFP transceiver modules for daisy-chaining up to 10 chassis
- **Power Supply Modules**—Universal-input (100-240VAC, 0.5Amp, 47-63Hz), hot-swappable power supplies with integrated cooling fans; each supply can power the unit independently; dual supplies provide redundancy to maximize uptime; -48VDC models are also available

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Chapter 2
Installing Director

This chapter describes how to install and connect Director devices. The procedure for installing Director follows these basic steps:

1. Plan the installation
2. Unpack and inspect the Director device
3. Install the DNM modules
4. Install the SFP and XFP modules
5. Rack mount the Director device
6. Connect power to Director
7. Connect the command line interface (CLI) RS-232 DB9 port or the Management port
8. Log into the CLI
9. Configure Director parameters using the CLI
10. Connect Director to the network with Span ports and in-line links
11. Connect the monitoring tools to Director
12. Configure a Matrix Switch connection in Director
13. Check the installation

This chapter pertains to installing a single Director. Chapter 4 addresses daisy-chaining up to 10 Director chassis into a single logical system.

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Plan the Installation

Before you begin the installation of your Director device, determine the following:

- Name that will identify the Director device
- IP address of the Director device, or a range of IP addresses if you are deploying multiple Director devices
- Net Mask for Director
- IP address of the remote management console, if deployed over a WAN; this address is used for SNMP traps
- Gateway to the remote management console, if deployed over a WAN
- Port assignments and filters for the Network and Monitor port connections

Make sure you have a suitable location to install the Director device. For power redundancy, use two independent power sources.

Unpack and Inspect the Director device

Carefully unpack the Director device, power supplies, and all cables that are provided. Director is delivered with the following:

- (1) Director device
- (2) Power cords
- Director Quick Install Guide (one sheet)
- (1) CD containing the Director User Guide (this document)
- Network and monitor cables
- RS-232 DB9 cable for use with the CLI
- Extended Warranty if purchased

Check the packing slip against parts received. If any component is missing or damaged, contact Net Optics Customer Service immediately at +1 (408) 737-7777. (Note: XFP modules are ordered and shipped separately.)

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Install Director Network Modules

If the Director Network Modules (DNMs) are not already installed when you receive the unit, install them by sliding them into the DNM slots in the front panel. (If there is a plate covering the DNM slot, remove it by unscrewing two thumb-screws, and then install the DNM module.) The DNM circuit boards ride in the rails provided in the slots. Push in the DNM firmly until you feel the connectors mate and the bezel is flush with the front panel, but do not force them. If you encounter resistance, withdraw the module and try again, making sure to align the circuit board in the rails and slide the module straight in. When the DNM is fully seated, fasten it to the front panel with the two captured thumbscrews.

If you are only using a single DNM, it should be installed in the left slot (Slot 1).

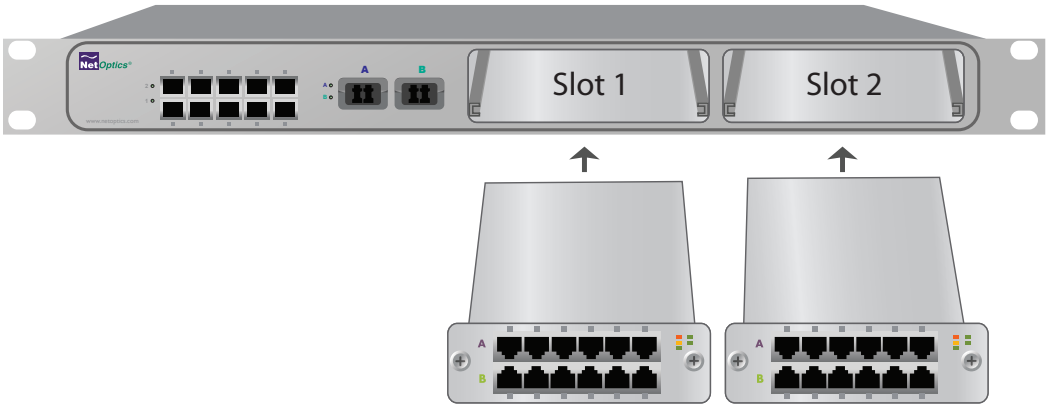

Figure 8: Installing Director Network Modules

Install SFP and XFP Monitor port Modules

SFP and XFP modules are shipped separately. Install them as desired in the SFP and XFP slots in the front on the chassis, and the two XFP slots in the rear. For each module, remove the temporary plug from the SFP or XFP slot and insert the module until it clicks into place. The photograph on the cover of this Guide shows properly installed SFP and XFP modules.

Rack Mount the Director device

Director is designed for rack mounting in a 19-inch rack panel. The panel occupies one rack unit. To rack mount the Director device, simply slide it into the desired rack location and secure it using the four supplied screws.

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Connect Power to Director

For power fault protection, Director is equipped with redundant power connections. If one power source becomes unavailable due to an interruption in AC power or failure of the power brick, the other power source keeps Director operating normally. If both power sources become unavailable, Director passively keeps all in-line network links open, passing all traffic between the network ports. (When power is not available, no data is seen at the Monitor ports.)

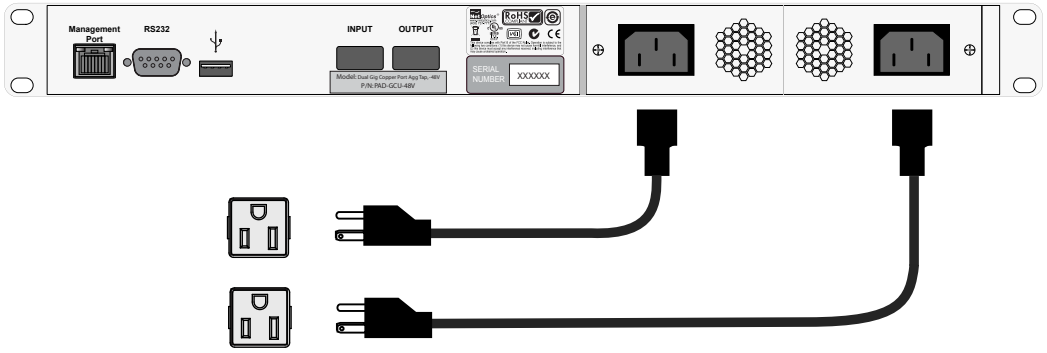

Figure 9: Connecting redundant power supplies

Supply power to Director using the power cords that were included with the unit. If you plan to use redundant power, make sure that you connect the power supplies to two separate, independent power sources for maximum protection. One or both Front Panel Power LEDs are illuminated, depending on whether you used one power supply or two.

Connect the local CLI Interface

All configuration options, filters, and status can be accessed using the Director Command Line Interface (CLI). You can run the CLI locally over the RS-232 serial port or remotely over the Management port.

If you choose to run the CLI locally, connect a DB9 cable from the RS-232 port on the back of the Director chassis to your computer; the computer needs to have terminal emulation software such as HyperTerminal to access the Director CLI.

To connect the CLI for local use over the RS-232 serial port:

1. Connect a PC with terminal emulation software, such as HyperTerminal, to Director using the RS-232 DB9 cable supplied with Director.

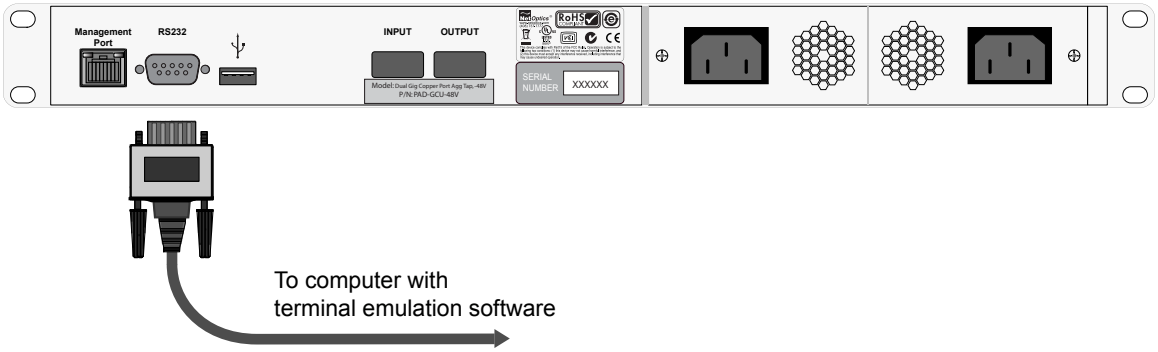

Figure 10: Connecting RS-232 Cable to Director

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2. Launch terminal emulation software and set communication parameters to:

   115200 baud
   8 data bits
   No parity
   1 stop bit
   No flow control

   The Net Optics CLI banner and login prompt are displayed in the Terminal Emulation software.

```
************************************************************
*       Net Optics Command Line Interface (CLI)            *
*                                                          *
*       Copyright (c) 2008 by Net Optics, Inc.             *
*                                                          *
*             Restricted Rights Legend                     *
*                                                          *
* Use,  duplication,  or disclosure by the Government is   *
* subject  to  restrictions as set forth in subparagraph   *
* (c)  of  the Commercial Computer Software - Restricted   *
* Rights  clause at FAR  sec. 52.227-19 and subparagraph   *
* (c)(1)(ii) of the Rights in Technical Data and Computer  *
* Software clause at DFARS sec. 252.227-7013.              *
*                                                          *
*        Net Optics, Inc.                                  *
*        5303 Betsy Ross Drive                             *
*        Santa Clara, California 95054 USA                 *
*        +1-408-737-7777                                   *
*                                                          *
************************************************************
Login user:
```

Figure 11: CLI sign-on banner

Connect the remote CLI Interface

If you choose to run the CLI remotely, connect a network cable from a switch to the Management port on the back of the Director chassis. Use any computer with an SSH client to access the CLI over the network.

Tip!

PuTTY is a freeware SSH client for Windows that can be downloaded from many sites on the Internet.

To connect the CLI for remote use over the Management port:

1. Connect the Director Management port to a network switch using a network cable.

2. Open Direct (the default IP address is 10.60.4.180 and the SSH port is 22) from an SSH client on the network. Director displays the shell login prompt.

```
login as:
```

Figure 12: Shell login prompt

3. Enter **customer** to log into the shell. The shell asks for the password.

```
login as: shellusername
customer@10.60.4.180's password:
```

Figure 13: Shell login

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4. Enter **netoptics** as the password. For security, the password is not displayed as you type it. The Director CLI runs and the CLI sign-on banner and login prompt are displayed.

```
login as: customer
customer@10.60.4.8's password:
Last login: Thu Sep  4 09:40:31 2008 from 10.30.1.62


*********************************************************
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*        5303 Betsy Ross Drive                          *
*        Santa Clara, California 95054 USA              *
*        +1-408-737-7777                                *
*                                                       *
*********************************************************
login user:
```

Figure 14: Shell login as customer (password "netoptics" is not displayed)

Log into the CLI

Each Director maintains a list of accounts for users authorized for access to that particular Director. The default account for new systems is User Name **admin** and Password **netoptics**.

To log into the CLI:

1. Enter the user name. (The default user name is **admin**.) The Enter Password prompt is displayed.

2. Enter the password. (The default password is **netoptics**.) For security, the password is not displayed as you type it. The CLI prompt is displayed.

```
login user: admin
password:
Net Optics>
```

Figure 15: Logging into the CLI

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Configure Director using the CLI

You should be logged into the Director CLI. The factory-set default values for Director are:

- Username: **admin**
- Password: **netoptics**

- IP Address: **10.60.4.180** (address for remote CLI, and for Compass manager software, when available)
- Netmask: **255.0.0.0** (associated with IP Address)
- Manager IP Address: **192.168.1.2** (address for SNMP traps)
- Gateway IP Address: **10.0.0.1** (associated with Manager IP Address)

- Display: **ON**
- Management Port: **ON**

The following default parameters apply to all ports (when available):

- Enable: **ON**
- Threshold: **50%**
- Link Fault Detection: **ON** (applies to 10/100/1000 in-line Network ports only)

A complete list of CLI commands can be viewed by typing Help at the CLI prompt. It is also provided in Appendix B. You will now use the CLI to:

- Change the login User Name and Password
- Assign a new IP Address, Netmask, and Gateway IP Addresses
- Assign new remote manager IP Address
- Change port modes
- Set the date and time
- Save and load Director configurations
- Try out the CLI Help command

Your CLI screen should be displaying the "Net Optics:" prompt as shown here:

```
Net Optics>
```

If you do not see the "Net Optics>" prompt, try typing Help followed by the Enter key. If the prompt is still not displayed, repeat the instructions in the preceding section **Connect the local CLI Interface** or **Connect the remote CLI Interface** and log in again.

Change Director User Name and Password

It is strongly recommended that you change the User Name and Password from the defaults to provide security against unauthorized access.

To change the user name and password:

1. Enter **user mod name=**<*new username*> **pw=**<*new password*>. The user name and password are changed.

2. Record the new user name and password in a secure location.

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Assign a New Director IP Address, Netmask, and Gateway IP Address

If you are using the local RS-232 serial interface to access the CLI, then you need to configure the IP Address that Compass management software, when available, will use to communicate with Director. If Director must communicate through a Gateway to reach the network, then set the Gateway IP Address for that Gateway.

If you are running the CLI remotely, you can change the IP Address, but when you do, you will lose your SSH connection since it is talking to the old IP Address. In that case, initiate a new SSH session to the new IP address and you can continue using the CLI remotely.

To assign a new IP Address, Netmask, and Gateway IP Address to Director:

1. Enter **sysip show**. The current IP Address, Netmask, and Gateway IP Address are displayed.
2. Enter **sysip set ipaddr=**<*new ip address*> **netmask=**<*new netmask*> **gw=**<*new gateway*>. The IP Address, Netmask, and Gateway IP Address are made pending.
3. Enter **sysip show**. Verify that the displayed IP Address, Netmask, and Gateway IP Address are the desired values.
4. Enter **sysip commit** to activate the new IP Address, Netmask, and Gateway IP Address.

Example: **sysip set ipaddr=10.60.4.180 netmask=255.0.0.0 gw=10.0.0.1**
sysip commit

Tip!

The **sysip** *command accepts one, two, or three parameters, so you only need to include the ones you want to change. For example, to change the IP Address but leave the Netmask and Gateway IP Address the same, enter* **sysip set ipaddr=**<*new ip address*>.

Assign a New Manager IP Address

Configure the Manager IP Address to the IP Address of the remote management server, for example an IBM Tivoli or HP OpenView server.

To assign a new Manager IP address to Director:

TBA

Change Port Modes

To change the port mode:

1. Enter **port set ports=**<*portlist*> **autoneg=**< *on | off*> **speed=**< *10 | 100 | 1000* > **duplex=**< *full | half*> to set the mode of a 10/100/1000 Copper port.

   Example: Enter **port set ports=n1.5 autoneg=off speed=100** to set Network Port 5 in DNM 1 to 100Mbps fixed speed. Duplex mode is left in its default state of full duplex.

2. Repeat Step 1 as desired for ports n1.2 to n1.12, n2.1 to n2.12, m.1 to m.12, and t.1 to t.2; this procedure only affects 10/100/1000 Copper ports.

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Tip!

You can change the modes of multiple ports in a single command by specifying the ports in the portlist. Use a comma to separate items in the list, and use a dash (-) to indicate a range. For example, this portlist includes the first three ports in DNM 1 and the first port in DNM 2: **ports=n1.1-n1.3,n2.1**

Set the Current Date and Time

Director maintains a time-of-day clock which is used to record the time of traffic peak utilization events. Time is based on the 24-hour clock. The clock must be initialized using the CLI or another management tool.

To change the current date and time:

1. Enter **time** *hh:mm:ss* where *hh* is hour, *mm* is minutes, and *ss* is seconds.

2. Enter **date** *mm/dd/yyyy* where *mm* is month, *dd* is day of the month, and *yyyy* is year.

Example: **time 12:20:00**
date 06/24/2008

Save and Load Director Configurations

The entire configuration of Director, including port configurations and filters, can be saved to and loaded from files stored on Director's internal disk drive. When working with these files from within the CLI, specify only a filename (up to 32 characters long) without an extension. The current configuration is automatically kept in a file named **defaultcfg**. This file is automatically loaded at power up or when the system is reset, so your configuration is persistent. However, you may wish to save copies of various configurations that you use for different purposes. For example, each person that uses the device can maintain a separate configuration.

To save the Director configuration:

- Enter **save** <*filename*> where <*filename*> is the name for this configuration. The configuration is saved.

To load a Director configuration:

- Enter **load** <*filename*> where <*filename*> is the name of a saved configuration. The configuration is loaded.

To view a list of all saved Director configurations:

- Enter **list**. A list of Director configurations is displayed.

To view a saved Director configuration:

- Enter **show** <*filename*> where <*filename*> is the name of a saved configuration. The configuration is displayed.

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Using the CLI Help Command

To view CLI help information:

1. Enter **Help** at the "Net Optics:" prompt. The list of help topics is displayed.

```
Net Optics> help

  ![#]                    - !number or up/down key for previous command
  commit                  - save local config to hardware
  date                    - set system date
  del                     - delete file 'name'
  filter                 - set for filter command
  help                    - view cli usage
  history                 - display command history list
  image                   - switch image
  list                    - list xml file
  load                    - load file 'name'
  logout                  - logout from cm server
  module                  - show installed modules in the system
  passwd                  - change password for ssh user's account
  ping                    - ping 'ipaddr'
  port                    - set port command
  restart                 - restart the whole system
  save                    - save file 'name'
  show                    - show all files 'name'
  stats                   - show/clear ports statistics
  sysip                   - show and set system network IP address
  time                    - set system time
  upgrade                 - upgrade image file
  user                    - manage user account
  quit or exit            - exit current cli session

Net Optics>
```

Figure 16: Director CLI Help command

2. To view the syntax for changing Director filter parameters, enter **help filter**.

3. Repeat with the command of interest to view the syntax for all commands available from the CLI.

For a complete description of all of the CLI commands, see Appendix B.

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Using the CLI Command History Buffer

You can save a lot of typing by using the command history buffer maintained by the CLI. The up- and down-arrow keys scroll forward and backward through the history buffer. To execute a command again, simply scroll to that command and press **enter**. Alternately, you can scroll to a command and then edit it inline before executing it. You can see a history of all the buffered commands by entering the **history** command. Any command in the history buffer can be accessed directly by entering ![#] where [#] is the number of the command in the buffer. Operation of the command history buffer is illustrated in the following example.

```
Net Optics> show
         show name - show all files 'name'
Net Optics> list
current config file:
lannie_090208
Net Optics> help ping
         ping ipaddr - ping 'ipaddr'
Net Optics> sysip show
Network Interface Info:
         Ipaddr:   10.60.4.180
         NetMask:  255.0.0.0       Gateway:  10.0.0.1
Net Optics> history
   1: show
   2: list
   3: help ping
   4: sysip show
Net Optics> !3
Net Optics> help ping
         ping ipaddr - ping 'ipaddr'
Net Optics>
```

Figure 17: CLI command history buffer

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Connect Span Ports to Director

To connect Director to the network using Span ports, be sure that at least one of your DNMs is a Span model. Use ports in that DNM to connect to the network.

Span port numbering is shown in the following diagram. It is the same for Span DNMs and in-line DNMs.

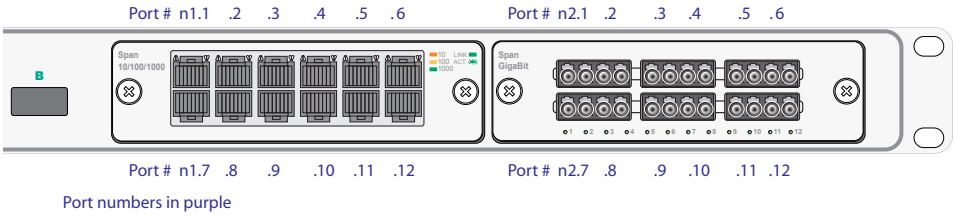

Figure 18: Port numbering for Span DNM models

Note:

DNM 1 is on the left and DNM 2 is on the right. In the CLI, the Network ports are designated using the letter N followed by the DNM number, a dot, and then the port number. For example, the Network port on the upper left is n1.1 and the Network port on the lower right is n2.12.

To connect a Span port:

1. Plug the appropriate cable into a Director Span port.

2. Plug the other end of the cable into the span port of the switch. The Link LED for the port illuminates after a short delay to indicate that a link has been established. If the Span traffic bandwidth is greater than about 300 Mbps, the two Link LEDs blink.

Repeat for all desired Span port connections.

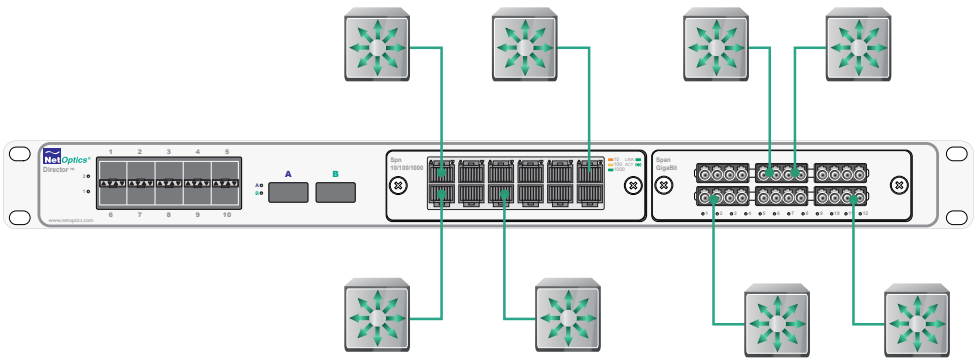

Figure 19: Span port connections

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Connect Director With In-line Network Links

To connect Director to the network using an in-line installation, be sure that at least one of your DNMs is an in-line model. Tap port-pairs for each link are located side by side, with three links across the top row and three links across the bottom row. This is true for both Fiber and 10/100/1000 DNMs.

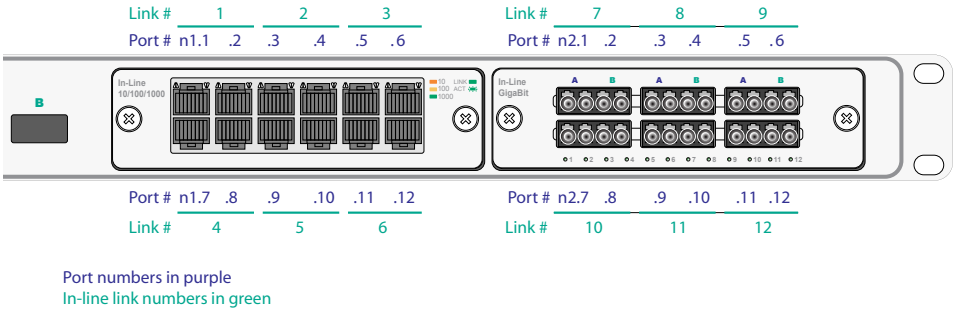
Link # 1 2 3
Port # n1.1 .2 .3 .4 .5 .6
Link # 7 8 9
Port # n2.1 .2 .3 .4 .5 .6
B
In-Line 10/100/1000
In-Line GigaBit
Port # n1.7 .8 .9 .10 .11 .12
Link # 4 5 6
Port # n2.7 .8 .9 .10 .11 .12
Link # 10 11 12
Port numbers in purple
In-line link numbers in green

Figure 20: Port and link numbering for in-line DNM models

To connect an in-line network link:

1. Plug the appropriate cable into an odd-numbered Network port (Port Nm.o).

2. Plug the other end of the cable into the source switch or router. The Link LED for the port illuminates after a short delay to indicate that a link has been established.

3. Plug another cable into the connector immediately to the right of Port Nm.o. It will be numbered 1 higher, or Port Nm.(o+1).

4. Plug the other end of the cable into the destination switch or router. The Link LED for the port illuminates after a short delay to indicate that a link has been established. If present, traffic passes between the source and destination switches or routers. If the traffic bandwidth is greater than about 300 Mbps, the two Link LEDs blink.

Repeat for all desired in-line network connections.

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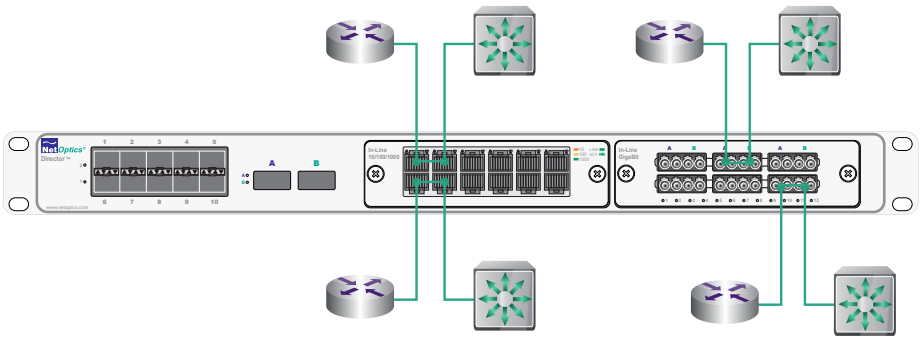

Figure 21: In-line Network connections

Connect Monitoring Tools to Director

To connect a monitoring tool to Director, simply plug the appropriate cable into the desired 1 Gigabit or 10 Gigabit Monitor port and plug the other end into the monitoring tool. The Link LED for the port should illuminate after a short delay to indicate that a link has been established. Repeat for all desired monitoring tool connections.

Note:

In the CLI, the Monitor ports are designated using the letter M followed by a dot, and then the port number. For example, the Monitor port on the upper left is m.1 and the Monitor port on the lower right is m.10.

Configure a Matrix Switch connection in Director

In order to monitor a network link, Director must be configured to copy the traffic from a Network or Span port to a Monitor port. A simple connection is described in this section, operating Director as a Matrix Switch. For more complex switching and filtering, see Chapter 3.

To monitor Network Port 1 (in DNM 1) on Monitor Port 2:

1. Enter **filter add in_ports=n1.1 action=redir redir_ports=m.2**. The switch connection is pending.

2. Enter **filter commit**. The switch connection is activated.

3. Verify that traffic present on Network Port 1 is visible on Monitor Port 2.

Check the Installation

You have connected Director to the network, monitoring tools, and power. It should now be functioning correctly. Check the status of the following:

- Check that at least one power LED is illuminated.
- Check the link status LEDs located on the front panel to verify that the links are connected.
- Verify that traffic is flowing through in-line connections to attached network devices.
- Verify that traffic present on Network port 1 is visible on Monitor Port 2.

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Chapter 3
Configuring Filters Using the CLI

This chapter describes how to use the CLI to determine which monitoring tools are connected to which Network ports. It also explains how to create filters to limit the amount of traffic copied to Monitor ports, so the monitoring tools receive only the traffic that is of interest to them.

In this chapter, you will learn to:

- Copy traffic from any Network port to any Monitor port
- Aggregate traffic from any set of Network ports to any Monitor port
- Regenerate traffic from any aggregated set of Network ports to any set of Monitor ports
- Create filters
- Create complex filters
- View filters
- Work with configurable 10 Gigabit ports
- Understand filter interactions

For a complete listing of filter commands in the CLI, see Appendix B.

Syntax

In the CLI, Director ports are specified by alpha-numeric names as follows:

- n1.1, n1.2, n1.3 .. n1.12 – Network ports in the first DNM (the slot on the left); for in-line DNM models, port n1.1, n1.2 are an in-line link pair; so are n1.3, n1.4, and so on.
- n2.1, n2.2, n2.3 .. n2.12 – Network ports in the second DNM (the slot on the right); for in-line DNM models, port n2.1, n2.2 are an in-line link pair; so are n2.3, n2.4, and so on.
- m.1, m.2, m.3 .. m.10 – Monitor ports
- t.1, t.2 – Configurable 10 Gigabit ports (on the front panel)

Most commands accept lists of ports. In port lists, port names are separated by commas and a dash (-) designates a range. Do not include any space characters in the list (do not put a space after the comma). For example, *n1.1,n1.2,n1.3,n1.4,n1.5-n1.10* is a list that includes Network Ports 1 through 10 on DNM 1.

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When you define a filter, you specify and **action** to be taken when the filter conditions are met. The **action** can be either **drop** or **redir** (meaning redirect). If the **action** is **drop**, then packets which meet the filter criteria are dropped, that is, they are not copied to any Monitor port. If the action is **redir**, then packets which meet the filter criteria are copied to all Monitor ports listed in the **redir_ports=<portlist>** parameter.

Copy Traffic From Any Network Port to Any Monitor Port

Director can be used like a Matrix Switch to direct traffic from any Network port to any Monitor port. To create a simple switch connection, use a **filter add** command without specifying any filters.

The **filter add** command creates pending filters (including switch settings); they are not activated until a **filter commit** command is executed. Any number of **filter add** commands may be issued prior to executing the **filter commit** command. Other CLI commands may be executed between the **filter add** commands as well.

To monitor Network Port 1 on Monitor Port 2, and Network Port 3 on Monitor Port 1:

1. Enter **filter add in_ports=n1.1 action=redir redir_ports=m.2**. The switch connection is pending.

2. Enter **filter add in_ports=n1.3 action=redir redir_ports=m.1**. The switch connection is pending.

3. Enter **filter commit**. The switch connection is activated.

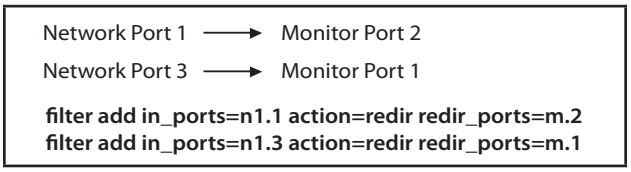
Network Port 1 → Monitor Port 2
Network Port 3 → Monitor Port 1
filter add in_ports=n1.1 action=redir redir_ports=m.2
filter add in_ports=n1.3 action=redir redir_ports=m.1

Figure 22: Matrix switch connections

Aggregate Traffic From Any Set of Network Ports to Any Monitor Port

Director can be used like a Port Aggregator or a Link Aggregator, copying traffic from multiple Network ports to any Monitor port. The **filter add** command is again used to do this. The only difference from using the command to connect a single Network port to a single Monitor port is that a list of Network ports is specified.

To copy aggregated traffic from Network Port 1 and Network Port 2 to Monitor Port 3:

1. Enter **filter add in_ports=n1.1,n1.2 action=redir redir_ports=m.3**. The aggregation connection is pending.

2. Enter **filter commit**. The aggregation connection activated.

Note that in this example, Network Port 1 and Network Port 2 may be Span ports, or they can be a paired in-line network link. The Network port list in the **filter add** command always applies to the traffic received at the port, not the traffic transmitted out the port. Therefore, if Network Port 1 and Network Port 2 are an in-line link, then Director has been configured to act as a Port Aggregator, combining the traffic from both directions on the in-line link and copying it to the Monitor port.

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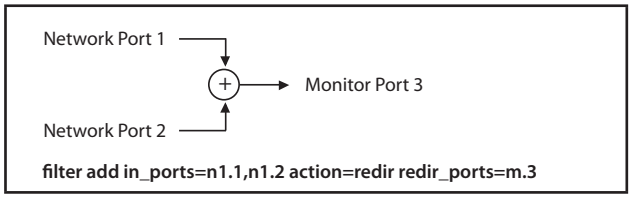

Figure 23: Traffic aggregation

Regenerate Traffic to Any Set of Monitor Ports

Director can be used like a Regeneration Tap, copying traffic from a Network port (or aggregated group of Network ports) to multiple Monitor ports. The **filter add** command is used to do this. The only difference from using the command to connect a single or multiple Network ports to a single Monitor port is that a list of Monitor ports is specified.

To regenerate traffic from Network Port 1 to Monitor Ports 3, 4, and 5:

1. Enter **filter add in_ports=n1.1 action=redir redir_ports=m.3-m.5**. The regeneration connection is pending.

2. Enter **filter commit**. The regeneration connection is activated.

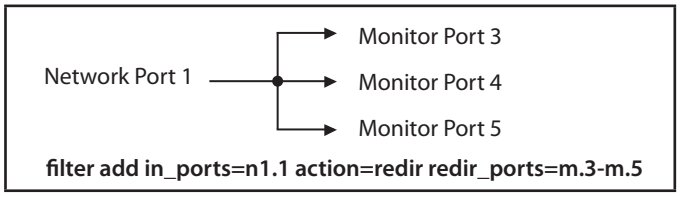

Figure 24: Traffic regeneration

To aggregate traffic from Network Port 10 and Network Port 11 and regenerate the resulting stream to Monitor Ports 9 and 10:

1. Enter **filter add in_ports=n1.10,n1.11 action=redir redir_ports=m.9,m.10**. The aggregation/regeneration connection is pending.

2. Enter **filter commit**. The aggregation/regeneration connection is activated.

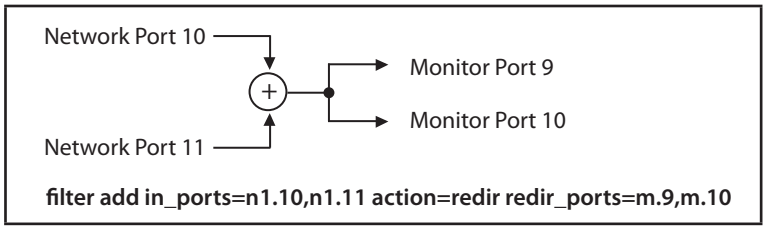

Figure 25: Combined aggregation and regeneration

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Create Filters

Filters process a traffic stream by selecting packets based on criteria in the packet header. A filter is defined using a **filter add** command, which also specifies the Network ports and Monitor ports the filters apply to. The **filter add** command specifies the following behavior:

- Traffic is aggregated from all the listed Network ports
- Then the filter parameters are applied
- Packets which match all of the specified filter parameters are copied to all of the listed Monitor ports, assuming the action=redir.
- If the action=drop, the matching packets are not copied to any Monitor port; this mechanism is used to create exclusive filters.

To send Monitor Port 1 all traffic received at Network Port 5 from IP addresses 192.168.10.0 to 192.168.10.15:

1. Enter **filter add in_ports=n1.5 ip_src=192.168.10.0 ip_src_mask= 240 action=redir redir_ports=m.1**. A filter has been defined to select all IPv4 packets from Network Port 5 with a source IP addresses of 192.168.10.0 and the lowest four address bits masked out (ignored); packets matching the filter are copied to Monitor Port 1.

2. Enter **filter commit**. The filter is activated.

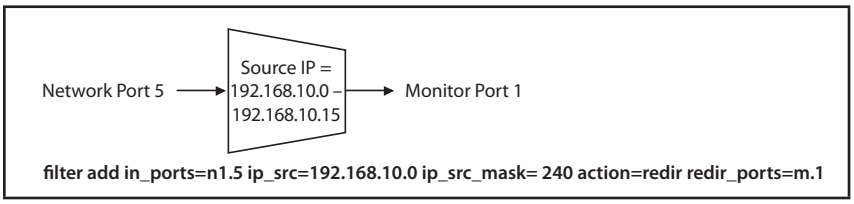

Figure 26: Simple IP address filter

To create a filter that selects IPv4 packets by protocol:

1. Enter **filter add in_ports=n1.3 ip4_prot=3 action=redir redir_ports=m.6,m.8.** A filter has been defined to select all IPv4 packets that use the TCP protocol received at Network Port 3 and copy them to Monitor Port 6 and Monitor Port 8. (Protocols are designated by an industry-standard numbering system. See Appendix C for details.)

2. Enter **filter commit**. The filter is activated.

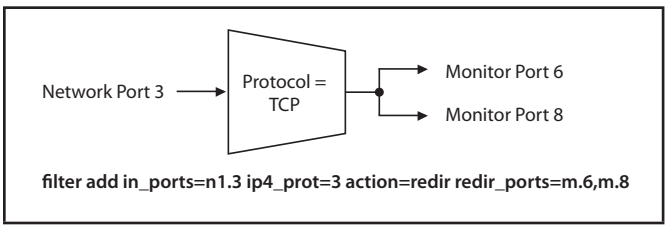

Figure 27: Simple IPv4 protocol filter (with regeneration)

Available filter parameters are listed in Appendix B and include:

- ip_src IP source address
- ip_src_mask IP destination address mask

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- ip_dst IP destination address
- ip_dst_mask IP source address mask
- ip_proto IP protocol
- l4_src_port Layer 4 source port
- l4_dst_port Layer 4 destination port
- vlan VLAN number

Create Complex Filters

Multiple filter parameters can be specified in a single **filter add** command. Packets must satisfy all of the filter parameters to be selected; in other words, the filter parameters have a logical AND connection.

To select all TCP traffic arriving from IP address 192.186.10.0:

1. Enter **filter add in_ports=n1.5 ip_src=192.186.10.0 ip_proto=6 action=redir redir_ports=m.1**. A filter has been defined to select all IPv4 TCP packets from Network Port 5 with a source IP address of 192.186.10.0; packets matching the filter are copied to Monitor Port 1.

2. Enter **filter commit**. The filter is activated.

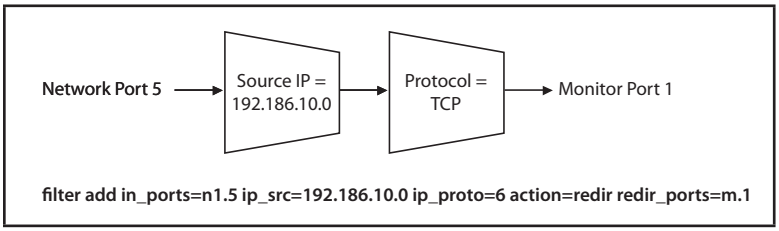
Network Port 5
Source IP = 192.186.10.0
Protocol = TCP
Monitor Port 1
filter add in_ports=n1.5 ip_src=192.186.10.0 ip_proto=6 action=redir redir_ports=m.1

Figure 28: Logical AND filter connection

A logical OR connection can be made between filters by specifying multiple filters with the same Network and Monitor port lists.

To select all packets which are either TCP or UDP protocol:

1. Enter **filter add in_ports=n1.5 ip_proto=6 action=redir redir_ports=m.1**. A filter has been defined to select all IPv4 TCP packets from Network Port 5 and copy them to Monitor Port 1.

2. Enter **filter add in_ports=n1.5 ip_proto=17 action=redir redir_ports=m.1**. Another filter has been defined to select all IPv4 UDP packets from Network Port 5 and copy them to Monitor Port 1.

3. Enter **filter commit**. The filters are activated.

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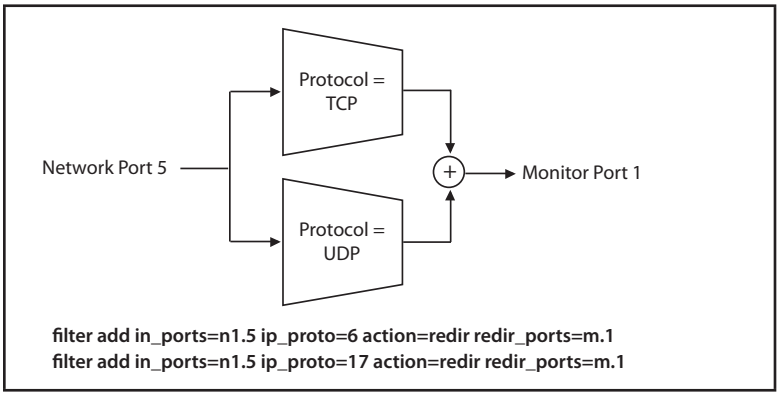

Figure 29: Logical OR filter connection

View filters

To view a list of all pending filters, enter **filter list**. To view the active filters, enter **filter running**.

```
Net Optics> filter list
001 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0000
    l4_src_port=0080,l4_dst_port=0000,vlan=0000,action=3
    in_ports=01
    redir_ports=13
002 ip_src=0a010101/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0000
    l4_src_port=0000,l4_dst_port=0000,vlan=0000,action=1
    in_ports=00 05
003 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0000
    l4_src_port=0000,l4_dst_port=0025,vlan=0000,action=3
    in_ports=00
    redir_ports=12
Net Optics>
```

Figure 30: Filter list command

Tip!

The ID numbers shown at the left of each filter in the **filter list** *are the IDs that apply for* **filter del id=<id>** *and* **filter inc id=<id>** *commands, because all three commands act on the pending filter lsit. Do not use the IDs in a* **filter running** *list as the reference for* **filter del** *or* **filter ins** *commands.*

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Work with configurable 10 Gigabit ports

The two configurable 10 Gigabit XFP ports on the front panel are designated t.1 (on the left) and t.2 (on the right). They can be used in network port lists and monitor port lists. The 10 Gigabit ports are configured for Network or Monitor as required by the **filter add** commands you enter. Some examples follow. If separate **filter add** commands require different configurations for the same XFP port, the port is configured as required for the command that was entered last.

To use both XFP ports as Network ports:

1. Enter **filter add in_ports=t.1 ip_proto=6 action=redir redir_ports=m.1**. A filter has been defined to select all IPv4 TCP packets from 10 Gigabit Port 1 and copy them to Monitor Port 1.

2. Enter **filter add in_ports=t.1 ip_proto=17 action=redir redir_ports=m.2**. A filter has been defined to select all IPv4 UDP packets from 10 Gigabit Port 1 and copy them to Monitor Port 2.

3. Enter **filter add in_ports=t.2 action=redir redir_ports=m.3**. A filter has been defined to copy all traffic from10 Gigabit Port 2 to Monitor Port 3.

4. Enter **filter commit**. The filters are activated.

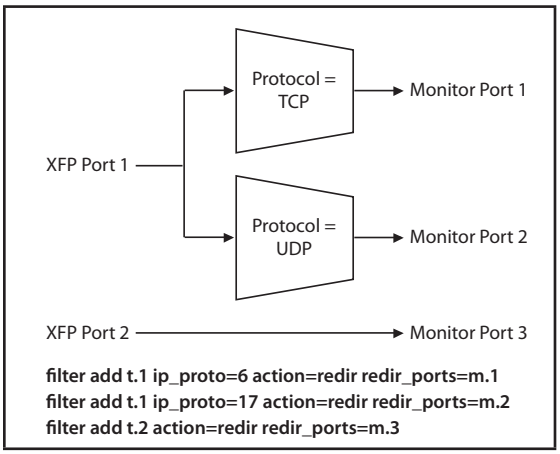

Figure 31: Configurable 10 Gigabit XFP ports used as Network ports

To use both XFP ports as Monitor ports:

1. Enter **filter add in_ports=n1.1-n1.4 action=redir redir_ports=t.1**. A filter has been defined to aggregate the traffic from the first four 1 Gigabit Network Ports and copy the aggregated traffic to 10 Gigabit Port 1.

2. Enter **filter add in_ports=n1.11 action=redir redir_ports=t.2**. A filter (switch) has been defined to copy all the traffic from 1 Gigabit Network Port 11 to 10 Gigabit Port 2.

3. Enter **filter commit**. The filters are activated.

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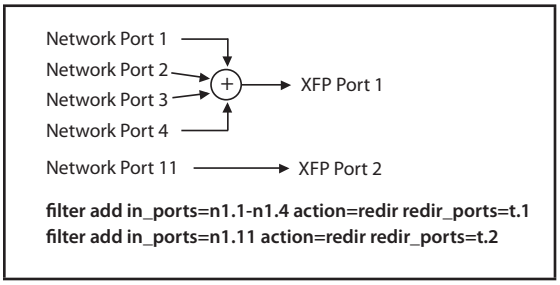

Figure 32: Configurable 10 Gigabit XFP ports used as Monitor ports (with aggregation)

To use one XFP port as a Span port and the other XFP port as a Monitor port:

1. Enter **filter add in_ports=t.1 ip_proto=6 action=redir redir_ports=m.1**. A filter has been defined to select all IPv4 TCP packets from 10 Gigabit Port 1 and copy them to Monitor Port 1. 10 Gigabit XFP Port 1 is configured as a Span port.

2. Enter **filter add in_ports=n1.11 action=redir redir_ports=t.2**. A filter has been defined to copy all the traffic from 1 Gigabit Network Port 11 to 10 Gigabit Port 2. 10 Gigabit XFP Port 2 is configured as a Monitor port.

3. Enter **filter commit**. The filters are activated.

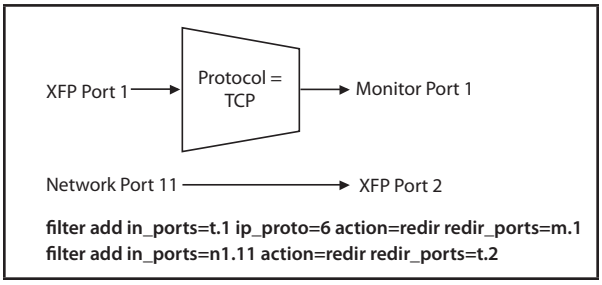

Figure 33: Configurable 10 Gigabit XFP ports used one Span port and one Monitor port

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Understand filter interactions

It is important to understand that Director uses Content Addressable Memory (CAM) technology to implement filters. As each filter is defined, it is stored in the next available entry in the CAM. Each packet header is compared in the CAM, and the CAM returns the index of the first filter that the packet header matched. That filter, and only that filter, controls which monitoring ports receive a copy of the packet. Other filters are not executed for that packet. Therefore, filters are not completely independent; one filter can affect the operation of another.

Let's walk through an example of a filter interaction that may be unexpected.

First, we will set up a filter for an IP address:

filter add in_ports=n1.5 ip_src=192.186.10.0 action=redir redir_ports=m.1
filter commit

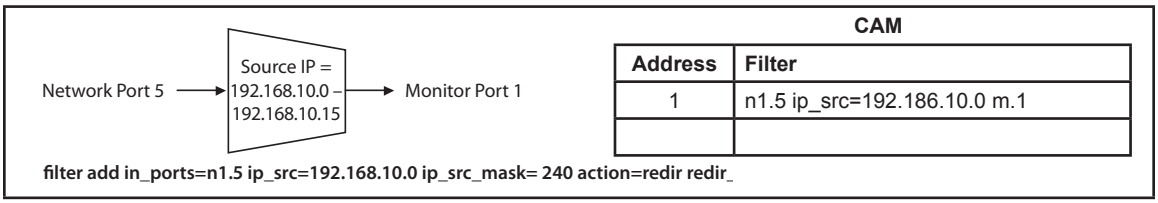

Figure 34: A simple IP address filter, shown with CAM

All traffic from Network Port 5 that comes from IP address 192.186.10.0 matches the first CAM entry and therefore is copied to Monitor Port 1.

Next, suppose we want another monitoring tool to see all the TCP traffic from Network Port 5, so we set up this filter:

filter add in_ports=n1.5 ip_proto=6 action=redir redir_ports=m.2
filter commit

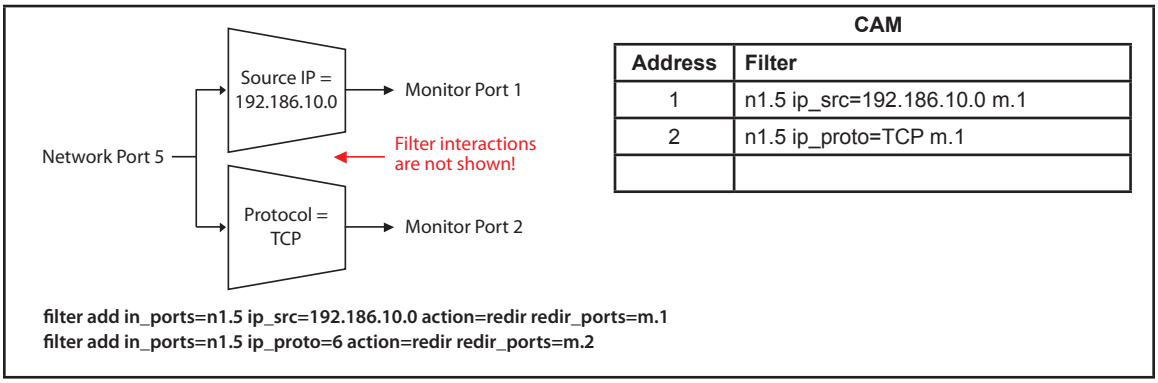

Figure 35: Incorrect flow diagram of two filters; filter interaction in CAM is neglected

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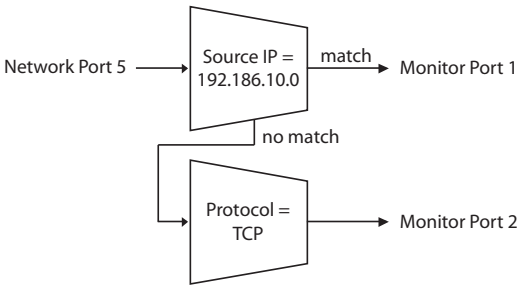
Have we achieved our goal of sending all the TCP traffic to Monitor Port 2? Not quite. What happens when an TCP packet arrives from 192.186.10.0? It matches the filter at CAM address 1, so it is copied to Monitor Port 1. But that is all that happens; it does not go to Monitor Port 2. The flow is correctly shown in the following diagram.



CAM

Address	Filter
1	n1.5 ip_src=192.186.10.0 m.1
2	n1.5 ip_proto=TCP m.2

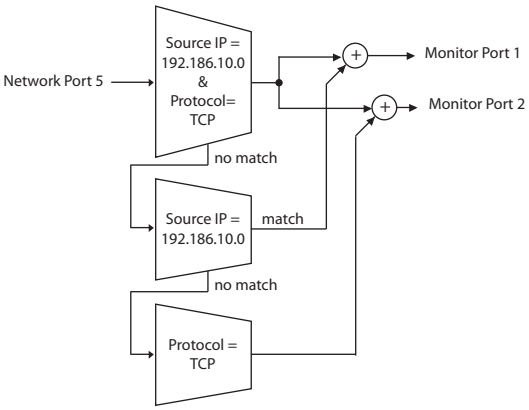
filter add in_ports=n1.5 ip_src=192.186.10.0 action=redir redir_ports=m.1
filter add in_ports=n1.5 ip_proto=6 action=redir redir_ports=m.2

Figure 36: Correct flow diagram for two interacting filters

To achieve the desired result of sending all TCP traffic to Monitor Port 2, clear the existing filters (**filter discard** command) and create three new filters by entering:

filter add in_ports=n1.5 ip_src=192.186.10.0 ip_proto=6 action=redir redir_ports=m.1,m.2
filter add in_ports=n1.5 ip_src=192.186.10.0 action=redir redir_ports=m.1
filter add in_ports=n1.5 ip_proto=6 action=redir redir_ports=m.2
filter commit

The flow diagram now looks as follows.



CAM

Address	Filter
1	n1.5 ip_src=192.186.10.0 ip_proto=TCP m.1,m.2
2	n1.5 ip_src=192.186.10.0
3	n1.5 ip_proto=TCP m.2

filter add in_ports=n1.5 ip_src=192.186.10.0 ip_proto=6 action=redir redir_ports=m.1,m.2
filter add in_ports=n1.5 ip_src=192.186.10.0 action=redir redir_ports=m.1
filter add in_ports=n1.5 ip_proto=6 action=redir redir_ports=m.2

Figure 37: Correct way to send all TCP traffic to Monitor Port 2

Now, packets that match both the IP address and protocol conditions will be copied to both Monitor ports, while packets that match only one of the conditions will be directed to the desired Monitor port.

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Note:

Instead of **filter add**, *you can use a* **filter ins** *command to define filters. The only difference is that* **filter ins** *allows you to specify the filter's ID, which is its position in the pending filter list. (Use* **filter list** *so see the IDs of all pending filters.) When you use a* **filter ins** *command, the first parameter must be* **id=<id>** *where <id> is a decimal number in the range 1 to 999. For example:* **filter ins id=2 in_ports=n1.1 out_ports=m.1** *defines a filter that sends all the traffic from Network Port 1 to Monitor Port 1 and places this filter in the second location in the pending filter list.*

Tip!

The **filter del** *command can be used to delete a filter from the pending filter list. The syntax is a* **filter del id=<id>** *where <id> is a decimal number in the range 1 to 999 corresponding to the position in the pending filter list. Use the* **filter list** *command so see the IDs of all pending filters.*

Exclusive filters

Filters can be specified using **action=drop** in order to create exclusive filters. (An exclusive filter excludes packets rather an including them.) For example, suppose you would like to monitor all traffic on a link except for the UDP traffic. To specify this filter, use the following commands. Note that the drop filter must come first so it is earlier in the CAM.

filter add in_ports=n1.1 ip_proto=17 action=drop
filter add in_ports=n1.1 action=redir redir_ports=m.1
filter commit

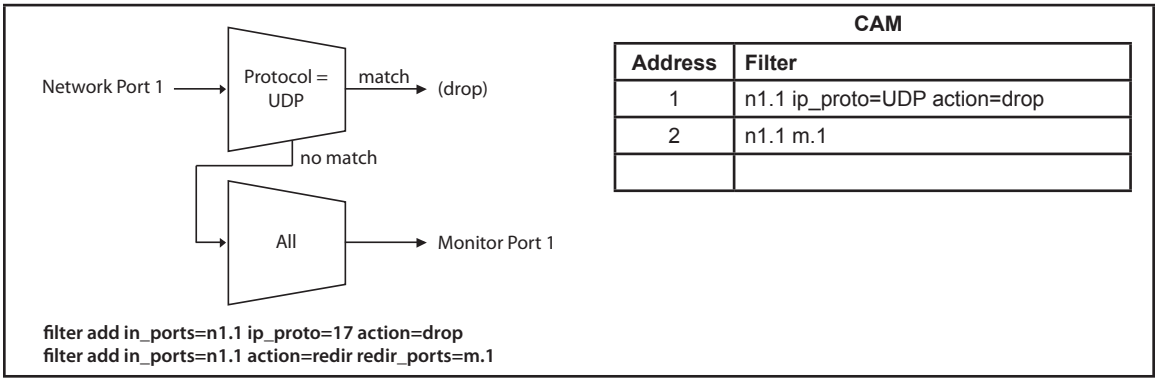

Figure 38: Creating an exclusive filter

Tip!

If you only define switch connections, with no filtering, the CAM is not involved and the switches do not interact.

Tip!

Filters that use exclusive sets of Network ports (each Network port is included in only a single filter) do not interact. For example,

filter add in_ports=n1.1-n1.5 *<filter_parameter_list> <monitor_port_list>*

does not interact with

filter add in_ports=n1.6-n1.10 *<filter_parameter_list> <monitor_port_list>*

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Understand pending and active filters

To understand the actions of **filter** commands such as **filter commit, filter discard,** and **filter delete,** it is helpful to visualize the pending filter list and the CAM that holds the active filters.

The previous section explained how the active filters are stored in a CAM, which can be thought of as list of active filters. These filters, which are actively running in the device, may be referred to as *active, running, or committed*. Pending filters, that is, filters that have been defined using **filter add** and **filter ins** commands but not yet committed, are kept in a pending filter list that shadows the CAM. These filters may be referred to as *pending* or *uncommitted*. The following table shows which filter commands affect the pending filter list and which affect the CAM.

Commands apply to	
Pending filter list	**CAM**
filter add	**commit**
filter del	**filter clear**
filter discard	**filter commit**
filter ins	**filter running**
filter list	
filter sync	

As can be seen from the table, most of the time you work with the contents of the pending filter list. When you have the filters set up the way you want them in the pending filter list, a **commit** or **filter commit** command transfers the contents of the pending filter list to the CAM, activating that filter set-up.

A common workflow for changing the Director filter configuration might be as follows.

To change the Director filter configuration:

Pending filter list

Address	Filter

CAM

Address	Filter
1	n1.1 ip_proto=UDP action=drop
2	n1.1 m.1

Figure 39: Starting state

1. Enter **filter running** to view the currently active filters in the CAM.

```
Net Optics> filter running
001 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0017
    l4_src_port=0000,l4_dst_port=0000,vlan=0000,action=1
    in_ports=00
002 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0000
    l4_src_port=0000,l4_dst_port=0000,vlan=0000,action=3
    in_ports=00
    redir_ports=12
Net Optics>
```

Figure 40: Filter running command

2. Enter **filter sync.** The contents of the CAM are copied to the pending filter list.

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Pending filter list		CAM	
Address	**Filter**	**Address**	**Filter**
1	n1.1 ip_proto=UDP action=drop	1	n1.1 ip_proto=UDP action=drop
2	n1.1 m.1	2	n1.1 m.1

Figure 41: After filter sync

3. Use **filter add, filter ins,** and **filter del** commands to change filters as desired.

Pending filter list		CAM	
Address	**Filter**	**Address**	**Filter**
1	n1.1 ip_proto=TCP action=drop	1	n1.1 ip_proto=UDP action=drop
2	n1.1 m.1	2	n1.1 m.1
3	n1.2 m.2		

Figure 42: Filter 1 has been changed and filter 3 has been added

4. Enter **filter list** to view the pending filter list.

```
Net Optics> filter list
001 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0006
    l4_src_port=0000,l4_dst_port=0000,vlan=0000,action=1
    in_ports=00
002 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0000
    l4_src_port=0000,l4_dst_port=0000,vlan=0000,action=3
    in_ports=00
    redir_ports=12
003 ip_src=00000000/ffffffff,ip_dst=00000000/ffffffff,ip_proto=0000
    l4_src_port=0000,l4_dst_port=0000,vlan=0000,action=3
    in_ports=01
    redir_ports=13
Net Optics>
```

Figure 43: Filter list command

6. Repeat steps 3 and 4 until the pending filter list is consistent with the desired filter configuration.

7. Enter **filter commit**. The contents of the pending filter list are copied to the CAM, activating the new filter configuration.

Pending filter list		CAM	
Address	**Filter**	**Address**	**Filter**
1	n1.1 ip_proto=TCP action=drop	1	n1.1 ip_proto=TCP action=drop
2	n1.1 m.1	2	n1.1 m.1
3	n1.2 m.2	3	n1.2 m.2

Figure 44: After filter commit

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Be aware of these similar pairs of commands:

- **filter discard** clears the pending filter list, while **filter clear** clears the CAM
- **filter list** shows the pending filter list, while **filter running** shows the CAM
- **filter commit** copies the pending filter list to the CAM, while **filter sync** copies the CAM to the pending filter list

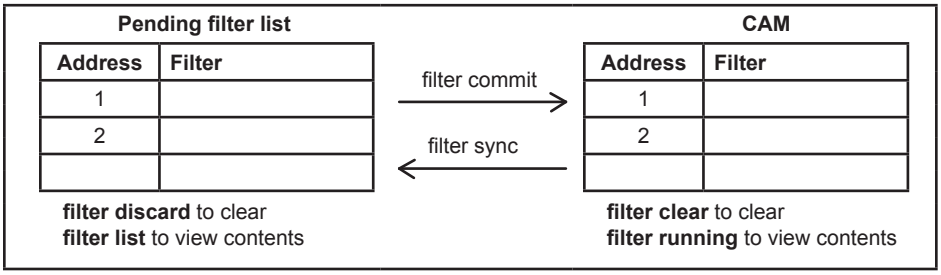

Figure 45: Pairs of similar filter commands

User interactions

When multiple users are logged into Director at the same time, each user has a separate pending filter list in which to create filter configurations. However, there is only one CAM, so any time a user executes a **commit** or **filter commit command**, the CAM takes on the filter configuration from that user's pending filter list, and those become the active filters on Director. For this reason, it is a good idea to use a **filter sync** to get the current contents of the CAM before adding or modifying filters; that way, the filters that you don't touch remain unaffected after you **commit**.

Filter capacity

The capacity of Director's filtering function is roughly 1,000 filter elements per chassis, where a filter element is a port list or a filter parameter. For example, **filter add in_ports=n1.1-n1.7 ip_proto=6 vlan=100 action=redir redir_ports=m.1-m.5,m.10** has four filter elements:

1. **in_ports=n1.1-n1.7**
2. **ip_proto=6**
3. **vlan=100**
4. **redir_ports=m.1-m.5,m.10**

Counting filter elements is only a rough gauge of filter utilization, and is not recommended. Instead, examine the pending filter list or CAM contents with **filter list** and **filter running** commands. The CAM has 512 locations, so the number of filter entries or filter IDs is an indication of how much filtering capacity has been utilized. For example, if the highest filter ID is 256, then half of the filter capacity is utilized. The actual capacity may exceed 1,000 filter elements because one CAM location can contain multiple filter elements. However, be aware that IPv6 addresses (when available) require additional CAM space and therefore fill the CAM more quickly than IPv4 addresses.

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Chapter 4
Daisy-chaining Multiple Director Chassis

This chapter describes how to expand the capacity of Director by daisy-chaining multiple Director chassis. The complete set of chassis becomes a single logical system with up to 380 total ports. By using long-reach ER links, chassis can be physically separated by as much as 25 miles (40 kilometers), enabling monitoring of entire campuses or multiple campuses with a single Director system.

Daisy-chaining chassis is not supported in the initial release of Director. This chapter will be expanded when daisy-chain functionality becomes available.

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Appendix A
Director Specifications

Specifications, chassis

Mechanical

Dimensions: 1.6” high x 15.65” deep x 17” wide
Mounting: Surface or 19” rack mount (1U)
Weight: TBA

Connectors

Network Port Slots: (2) Director Network Module (DNM)
Monitor Ports: (10) SFP
Configurable 10Gigabit Ports: (2) XFP
Daisy-chain (uplink) 10Gigabit Ports: (2) XFP
Management Port: (1) RJ45 10/100 Copper Network
Configuration (CLI) Port: (1) RS-232 DB9
USB Port: (1) Supports thumb drives for software loading
Power: (2) AC universal

Electrical Interface

Power: 100-240VAC, 2A, 47-63Hz (Japan: 100-125VAC, ~120 VA, 50-60Hz), -48VDC available

Indicators

(All ports) Link LEDs (with speed indication on Copper ports),
(All ports) Activity LEDs
(1) Alarm LED
(2) Power LEDs

Performance

Hardware throughput: 74Gbps
TapFlow Smart filtering: More than 1,000 filter elements per chassis; filter by IP source address , IP destination address, MAC source address, MAC destination address, source port, destination port, protocol, network port or port group, VLAN, utilization threshold
RMON statistics for each network and monitor port: Current utilization, peak utilization, peak time, total packets, total bytes, CRC errors, collision packets, oversize packets, undersize packets
Alarms: Programmable utilization threshold alarm for each network and monitor port
Internal disk drive: 2.5-inch, SATA, 30 Gigabyte, 5400 RPM

Software

Net Optics Web Manager—compatible with all major Web browsers
Net Optics System Manager—compatible with Windows XP, Windows 2000, and Windows 98
SNMP v3 support

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Specifications, DNM

Copper Interface

(12) RJ45 Network Ports 10/100/1000Mbps
(6) In-line links or (12) Span ports depending on model
22-24 AWG unshielded twisted pair cable, CAT5e or better recommended

Fiber Optic Interface

(12) Gigabit SX, LX, or ZX Network Ports, LC type
(6) In-line links or (12) Span ports depending on model
Fiber Types: Corning Multimode 62.5/125µm
Corning Multimode 50/125µm
Corning Singlemode 8.5/125µm
Transceiver: SX GigaBit 850nm, VCSEL, supports 62.5/125µm
SX GigaBit 850nm, VCSEL, supports 50/125µm
LX GigaBit 1310nm, laser, supports 8.5/125µm
ZX GigaBit 1550nm, laser, supports 8.5/125µm
Safety: Class 1, eye-safe, laser emitter type; conforms to the applicable requirements per US 21 CFR (J) and EN 60825-1; also UL 1950 applications

Environmental

Operating Temperature: 0˚C to 55˚C
Storage Temperature: -10˚C to 70˚C
Relative Humidity: 10% min, 95% max, non-condensing

Certifications

FCC, CE, FCC, VCCI, C-Tick, and WEEE certified
Fully RoHS compliant

Available Models

Models, Main Chassis

DIR-3400	Director Main Chassis with 10 SFP monitor ports
DIR-____	Director Main Chassis with 10 SFP monitor ports, -48VDC power
DIR-7400	Director Main Chassis with 10 SFP monitor ports, 2 XFP 10GbE ports, 2 XFP uplink ports
DIR-____	Director Main Chassis with 10 SFP monitor ports, 2 XFP 10GbE ports, 2 XFP uplink ports, -48VDC power

DNMs

DNM-100	6-Port 10/100/1000 Copper In-Line Module
DNM-110	12-Port 10/100/1000 Copper Span Module
DNM-200	6-Port Gigabit SX Fiber 62.5µm In-Line Module
DNM-210	12-Port Gigabit SX Fiber 62.5µm Span Module
DNM-220	6-Port Gigabit SX Fiber 50µm In-Line Module
DNM-230	12-Port Gigabit SX Fiber 50µm Span Module
DNM-300	6-Port Gigabit LX Fiber In-Line Module
DNM-310	12-Port Gigabit LX Fiber Span Module
DNM-320	6-Port Gigabit ZX Fiber In-Line Module
DNM-330	12-Port Gigabit ZX Fiber Span Module

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Appendix B
Command Line Interface

Tip!

The command line interface (CLI) is not case sensitive.

Port numbering:

- Network ports are numbered Ns.p where
  - s is the DNM module (1 or 2; 1 is on the left, 2 is on the right)
  - p is the port number within the DNM (1 through 12)
  - for example, n2.1 and n2.12 are the lowest and highest port numbers in the second DNM Monitor ports are numbered m.1 through m.10
- Configurable 10 Gigabit ports are numbered t.1 and t.2
- a *portlist* is a list of ports separated by commas; dashes may be used to specify ranges; for example, n1.1,n1.2,n1.3 and n1.1-n1.3 mean the same thing; NOTE: Do not include any space characters in the list (do not put a space after the comma)

A *string* is a string of characters up to 32 characters in length, not case sensitive; valid characters are A-Z, a-z, 1-9, -, _

Parameters marked with an asterisk (*) are required, and must be the first parameter in the parameter list for the command. Other parameters are optional and may be included in any order.

Command	Sub-Command	Parameters	Example and description
!		[#] (a number)	*!3* Executes a command from the CLI command history buffer (see *history* command)
commit			*commit* Activates pending changes previously defined using *filter* commands; same as a *filter commit* command
date		<date>	*date 06/24/2008* Parameters: <date> is mm/dd/yyyy Sets the system calendar date; if <date> is omitted, the current date is displayed
del		<filename>*	*del my_configuration-1* Parameters: <filename> is the name of the file to delete; a *string*; do not include an extension Deletes a previously saved Director configuration file (see *save* command)
exit			*exit* Exits the CLI shell (same as *logout* and *quit*)

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Command	Sub-Command	Parameters	Example and description
filter	add	ipv6=< y | n > in_ports=<network_portlist>* <qual>=<value> action=< redir | drop > redir_ports=<monitor_portlist> *Notes:* *The command may include any number of <qual>, up to the limit of Director's filter resources (approximately 1,000 <qual> per chassis)* *The action=< redir | drop > parameter is required* *If action=redir, then redir_ports=<monitor_portlist> parameter is required*	*filter add ipv6=n in_ports=n1.1-n1.3 ip_src=10.1.1.1 action=drop* Parameters: *ipv6=y* for IPv6 addressing; *ipv6=n* for IPv4 addressing (defaults to IPv4 if parameter is omitted) <network_portlist> — traffic from the network ports specified in this *portlist* is aggregated before being sent to the filter <qual> and <value> are filter qualifiers and values as listed in the table that follows this table Specify *redir* or *drop* as the filter action — if *redir,* packets matching *all* of the <qual> are copied to all of the Monitor ports specified in the *portlist* <monitor_portlist> if *drop,* packets matching *all* of the <qual> are dropped Defines a filter, including the Network and Monitor ports involved in the filter; filter is pending (inactive) until activated by a *filter commit* or *commit* command Note: If the *filter* command does not include any <qual>, it defines aggregation, regeneration, and matrix switching functions without filtering
	clear		*filter clear* Clears all active filters
	commit		*filter commit* Activates pending filters previously defined using *filter add* and *filter ins* commands
	del	ipv6=< y | n > id=<id>*	*filter del id=3* Parameters: *ipv6=y* for IPv6 addressing; *ipv6=n* for IPv4 addressing (defaults to IPv4 if parameter is omitted) <id> is a decimal number from 1 to 999 that identifies which filter is to be deleted Deletes a pending filter
	discard		*filter discard* Clears all pending filters
	ins	ipv6=< y | n > id=<id>* in_ports=<network_portlist> <qual>=<value> action=< redir | drop > redir_ports=<monitor_portlist>	*filter ins id=myfilter-1 in_ports=n1.1-n1.3 ip_src=10.1.1.1 action=drop* Parameters: *ipv6=y* for IPv6 addressing; *ipv6=n* for IPv4 addressing (defaults to IPv4 if parameter is omitted) <id> is a decimal number from 1 to 999 that specifies the priority of this filter (the address for the filter in the filter CAM) The rest of the filters parameters are as defined for the *filter add* command Defines and prioritizes a filter

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Command	Sub-Command	Parameters	Example and description
filter (continued)	list	ipv6=< y | n >	*filter list* Parameters: *ipv6=y* for IPv6 addressing; *ipv6=n* for IPv4 addressing (defaults to IPv4 if parameter is omitted) Displays all pending filters (with filter IDs)
	running	ipv6=< y | n >	*filter running* Parameters: *ipv6=y* for IPv6 addressing; *ipv6=n* for IPv4 addressing (defaults to IPv4 if parameter is omitted) Displays all active filters
	sync		*filter sync* Loads the pending filter list with a copy of the currently active filters
help		<command>	*help filter* Parameter: <command> is any CLI command Displays information about the specified CLI command; if <command> is omitted, displays a list of all CLI commands
history			*history* Displays a numbered list of previously executed CLI commands; any command can be executed directly by entering the command number preceded by an exclaimation point; up- and down-arrow keys can be used to scroll through the command history buffeer (see *!* command)
image		< 1 | 2 >	*image 2* Parameter: Valid values are 1 and 2 Chooses which system image to boot from; if <n> is omitted, the current system image information is displayed (see *upgrade* command)
list			*list* Shows a list of filenames of saved Director device configurations (see *save* command)
load		<filename>*	*load my_configuration-1* Parameters: <filename> is the name of the file to load; a *string;* do not include an extension Loads a previously saved Director configuration (see *save* command)
logout			*logout* Exits the CLI shell (same as *exit* and *quit*)
module	show		*module show* Lists information about Director hardware modules including system serial number, DNM types, and XFPs

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Command	Sub-Command	Parameters	Example and description
passwd			*passwd* Interactively changes the password of the SSH user account
ping		<address>*	*ping 10.1.1.4* Parameters: <address> is an IP address Pings the specified IP address to check for connectivity
port	set	ports=<portlist>* autoneg=< on | off > duplex=< full | half > speed=< 10 | 100 | 1000 >	*port set n1.1-n1.3 autoneg=on duplex=full* Parameters: <portllist> is a *portlist* For other parameters, select a value from the listed choices For 10/100/100 Copper interface Network and Monitor ports, enables or disables autonegotiation; selects the duplex mode; and sets the fixed speed (10Mbps, 100Mbps, or 1000Mbps) if autonegotiation is **off**
	show		*port show* Displays the current port status and settings
quit			*quit* Exits the CLI shell (same as *exit* and *logout*)
restart			*restart* Reboots the Director device; also called warm boot; similar to power-cycling the device; does not change the configuration parameters or filters
save			*save my_configuration-1* Parameters: <filename> is the name of the file where the configuration is saved; a *string;* do not include an extension Saves the Director device configuration to a file; saved information includes port set-up and filters
show		<filename>*	*show my_configuration-1* Parameters: <filename> is the name of the file to display; a *string;* do not include an extension Displays the contents of the specified saved configuration file (see **save** command)
stats	clear	ports=all|<[portlist>	*stats clear ports=all* Clears RMON statistics for the designated ports
	show	ports=all|<[portlist>	*stats show ports=m.2,n1.4* Displays RMON statistics for the designated ports

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Command	Sub-Command	Parameters	Example and description
sysip	commit		*sysip commit* Activates pending changes defined with *sysip set*
	set	ipaddr=<address> netmask=<netmask> gw=<gateway>	*sysip ipaddr=192.168.1.2 netmask=255.255.0.0>* Parameters: <address> is the IP address (default: 192.168.1.2) <netmask> is the netmask (default: 255.0.0.0) <gateway> is the gateway IP address (default: 192.168.1.1) Sets the Director IP address, netmask, and gateway IP address; requires a **sysip commit** command to activate the new settings
	show		*sysip show* Displays the current Director IP address information
time		<time>	*time 13:02:00* Parameters: <time> is hh:mm:ss Sets the system time-of-day; if <time> is omitted, the current time is displayed
upgrade		srvip=<svrip> user=<username> pw=<passwd> filename=<filename>	*upgrade srvip=168.192.20.2 user=bob pw=bobpw filename=image021108 2* Parameter: <svrip> is the IP address of the server that the new image file is on <username> is the user name needed for FTP access to the server <passwd> is the password needed for FTP access to the server <filename> is the name of the image file Replaces the current system boot image with the image in the specified file (see *image* command); all parameters must be included and they must be in the order shown

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Command	Sub-Command	Parameters	Example and description
user *This command is only available at root level*	show		*user show* Lists all the currently defined user accoounts *This command is only available at root level*
	add	name=<username>* pw=<password> priv=<level> *Notes:* *All three parameters are required, and they must be in the order shown*	*user add name=bob pw=bob-pw priv=3* Parameters: <username> is the username, a *string* <password> is the password, a *string* <level> is 1, 2, or 3 (other values not applicable); 1=root; 2=admin; 3=user Creates a new user account *This command is only available at root level*
	del	name=<username>	*user del name=bill* Parameters: <username> is the user name of the account you wish to delete Deletes a user account *This command is only available at root level*
	mod	name=<username> pw=<password> priv=<level>	*user mod name=bill pw=billpw* Parameters: <username> is the user name of the account you want to change, a *string* <password> is the new password for the account to, a *string* <level> is 1, 2, or 3 (other values not applicable); 1=root; 2=admin; 3=user Modifies a user account *This command is only available at root level*

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Filter parameters

Switches and filters are defined using the **filter add** and **filter ins** commands. The **filter add** command syntax is:

filter add in_ports=<*portlist*> <filter_parameter_list> action=<redir|drop> redir_ports=<*portlist*>

The <filter_parameter_list> is a sequence of zero or more of the filter qualifiers as listed in the following table.

If the <filter_parameter_list> is empty, the **filter add** command specifies an aggregation of the traffic received on all of the in_ports. If the action=redir, the aggregated traffic stream is regenerated to all of the redir_ports.

If the <filter_parameter_list> contains filters, aggregation and regeneration take place as described in the previous paragraph. However, the filters are applied to the aggregated traffic stream before it is copied to the Monitor ports. If multiple filter qualifiers are specified, a packet must satisfy all of the filter qualifiers in order to be copied to the Monitor ports. In other words, the filter qualifiers are combined with a logical AND condition. A logical OR condition can be created by using multiple **filter add** commands with identical port lists.

The **filter add** and **filter ins** commands define filters but do not activate them. A subsequent **filter commit** or **commit** command must be executed to the filters. This mechanism enables an interrelated group of filters to be activated simultaneously. It also allows you to double-check your filter definitions before you activate them.

It is important to note that packets are filtered using a Content Addressable Memory or CAM. Each filter is a CAM entry, and the CAM is filled in the order that the **filter add** commands are received. **Filter ins** commands create filters in specific locations in the CAM. When a packet is processed, the first filter in the CAM that matches the packet is the only filter that is activated. Each packet can activate exactly zero or one filters. See **Understand filter interactions** near the end of Chapter 3 for examples.

All supported filter qualifiers are shown in the following table.

Director Filter Parameters

<qual>	<value>	Example	Description
ip_src	IPv4 address	*ip_src=168.10.4.1*	IP source address
ip_src_mask	IPv4 address mask	*ip_src_mask=255.255.255.0*	Mask for IP source address
ip_dst	IPv4 address	*ip_dst=1234:5678::9abc*	IP destination address
ip_dst_mask	IPv4 address mask	*ip_dst_mask=255.255.255.0*	Mask for IP destination address
ip_proto	Number*	*ip_proto=6*	Layer 4 IP protocol
l4_src_port	Port number	*l4_src_port=80*	Layer 4 source port
l4_dst_port	Port number	*l4_dst_port=80*	Layer 4 destination port
vlan	VLAN number	*vlan=128*	VLAN

* See Appendix C for a complete list of protocol numbers. Some common protocols include:

Number	Keyword	Protocol
1	ICMP	Internet Control Message Protocol
2	IGMP	Internet Group Message Protocol
6	TCP	Transmission Control Protocol
17	UDP	User Datagram Protocol
89	OSPF	Open Shortest Path First
132	SCTP	Stream Control Transmission Protocol

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Appendix C
Protocol Numbers

The official Assigned Internet Protocol Numbers list is maintained by the Internet Assigned Numbers Authority and can be found at http://www.iana.org/assignments/protocol-numbers. The list as of April 18, 2008 is reproduced in the following table (without references).

Num	Keyword	Protocol
0	HOPOPT	IPv6 Hop-by-Hop Option
1	ICMP	Internet Control Message
2	IGMP	Internet Group Management
3	GGP	Gateway-to-Gateway
4	IP	IP in IP (encapsulation)
5	ST	Stream
6	TCP	Transmission Control
7	CBT	CBT
8	EGP	Exterior Gateway Protocol
9	IGP	any private interior gateway (used by Cisco for their IGRP)
10	BBN-RCC-MON	BBN RCC Monitoring
11	NVP-II	Network Voice Protocol
12	PUP	PUP
13	ARGUS	ARGUS
14	EMCON	EMCON
15	XNET	Cross Net Debugger
16	CHAOS	Chaos
17	UDP	User Datagram
18	MUX	Multiplexing
19	DCN-MEAS	DCN Measurement Subsys-tems
20	HMP	Host Monitoring
21	PRM	Packet Radio Measurement
22	XNS-IDP	XEROX NS IDP
23	TRUNK-1	Trunk-1
24	TRUNK-2	Trunk-2
25	LEAF-1	Leaf-1
26	LEAF-2	Leaf-2
27	RDP	Reliable Data Protocol
28	IRTP	Internet Reliable Transaction
29	ISO-TP4	ISO Transport Protocol Class 4

Num	Keyword	Protocol
30	NETBLT	Bulk Data Transfer Protocol
31	MFE-NSP	MFE Network Services Protocol
32	MERIT-INP	MERIT Internodal Protocol
33	DCCP	Datagram Congestion Control Protocol
34	3PC	Third Party Connect Protocol
35	IDPR	Inter-Domain Policy Routing Protocol
36	XTP	XTP
37	DDP	Datagram Delivery Protocol
38	IDPR-CMTP	IDPR Control Message Transport Proto
39	TP++	TP++ Transport Protocol
40	IL	IL Transport Protocol
41	IPv6	Ipv6
42	SDRP	Source Demand Routing Protocol
43	IPv6-Route	Routing Header for IPv6
44	IPv6-Frag	Fragment Header for IPv6
45	IDRP	Inter-Domain Routing Pro-tocol
46	RSVP	Reservation Protocol
47	GRE	General Routing Encapsula-tion
48	DSR	Dynamic Source Routing Protocol
49	BNA	BNA
50	ESP	Encap Security Payload
51	AH	Authentication Header
52	I-NLSP	Integrated Net Layer Security TUBA
53	SWIPE	IP with Encryption
54	NARP	NBMA Address Resolution Protocol

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Num	Keyword	Protocol
55	MOBILE	IP Mobility
56	TLSP	Transport Layer Security Protocol using Kryptonet key management
57	SKIP	SKIP
58	IPv6-ICMP	ICMP for IPv6
59	IPv6-NoNxt	No Next Header for IPv6
60	IPv6-Opts	Destination Options for IPv6
61		any host internal protocol
62	CFTP	CFTP
63		any local network
64	SAT-EXPAK	SATNET and Backroom EXPAK
65	KRYPTO-LAN	Kryptolan
66	RVD	MIT Remote Virtual Disk Protocol
67	IPPC	Internet Pluribus Packet Core
68		any distributed file system
69	SAT-MON	SATNET Monitoring
70	VISA	VISA Protocol
71	IPCV	Internet Packet Core Utility
72	CPNX	Computer Protocol Network Executive
73	CPHB	Computer Protocol Heart Beat
74	WSN	Wang Span Network
75	PVP	Packet Video Protocol
76	BR-SAT-MON	Backroom SATNET Monitoring
77	SUN-ND	SUN ND PROTOCOL-Temporary
78	WB-MON	WIDEBAND Monitoring
79	WB-EXPAK	WIDEBAND EXPAK
80	ISO-IP	ISO Internet Protocol
81	VMTP	VMTP
82	SECURE-VMTP	SECURE-VMTP
83	VINES	VINES
84	TTP	TTP

Num	Keyword	Protocol
85	NSFNET-IGP	NSFNET-IGP
86	DGP	Dissimilar Gateway Protocol
87	TCF	TCF
88	EIGRP	EIGRP
89	OSPFIGP	OSPFIGP
90	Sprite-RPC	Sprite RPC Protocol
91	LARP	Locus Address Resolution Protocol
92	MTP	Multicast Transport Protocol
93	AX.25	AX.25 Frames
94	IPIP	IP-within-IP Encapsulation Protocol
95	MICP	Mobile Internetworking Control Pro.
96	SCC-SP	Semaphore Communications Sec. Pro.
97	ETHERIP	Ethernet-within-IP Encapsulation
98	ENCAP	Encapsulation Header
99		any private encryption scheme
100	GMTP	GMTP
101	IFMP	Ipsilon Flow Management Protocol
102	PNNI	PNNI over IP
103	PIM	Protocol Independent Multicast
104	ARIS	ARIS
105	SCPS	SCPS
106	QNX	QNX
107	A/N	Active Networks
108	IPComp	IP Payload Compression Protocol
109	SNP	Sitara Networks Protocol
110	Compaq-Peer	Compaq Peer Protocol
111	IPX-in-IP	IPX in IP
112	VRRP	Virtual Router Redundancy Protocol
113	PGM	PGM Reliable Transport Protocol
114		any 0-hop protocol

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Num	Keyword	Protocol
115	L2TP	Layer Two Tunneling Protocol
116	DDX	D-II Data Exchange (DDX)
117	IATP	Interactive Agent Transfer Protocol
118	STP	Schedule Transfer Protocol
119	SRP	SpectraLink Radio Protocol
120	UTI	UTI
121	SMP	Simple Message Protocol
122	SM	SM
123	PTP	Performance Transparency Protocol
124	ISIS over IPv4	
125	FIRE	
126	CRTP	Combat Radio Transport Protocol
127	CRUDP	Combat Radio User Data-gram
128	SSCOP-MCE	
129	IPLT	
130	SPS	Secure Packet Shield
131	PIPE	Private IP Encapsulation within IP
132	SCTP	Stream Control Transmission Protocol
133	FC	Fibre Channel

Num	Keyword	Protocol
134	RSVP-E2E-IGNORE	
135	Mobility Header	
136	UDPLite	
137	MPLS-in-IP	
138	manet	MANET Protocols
139	HIP	Host Identity Protocol
140 to 252		Unassigned Use for experimentation and testing
253		
254		Use for experimentation and testing
255	Reserved	

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